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POTTERY MANAGEMENT

(A practical guide to factory managers and students of Ceramics)

BY

H. N. BOSE.

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"An Introduction to Silicate Industries"
etc.

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PREFACE

India's economic future demands that there should be a regular and well planned drive to develop and expand her industries. The experiences of the last great world war have amply demonstrated the potential capacities of Indian workers and her resources. It is only up to us now to plan all our new enterprises on sound economic basis so that our products can compete in open markets.

Pottery and porcelain have now become the part and parcel of modern civilization and have contributed materially towards the progress of science and technology. In view of their developments, it would be wrong to consider the ceramic articles of to day merely as consumer goods, as many people think even now. Two successive world wars have amply proved the great importance of ceramic wares and we can safely say now that ceramic industries are key industries but for which the modern developments of other industries are impossible.

The essential factors which largely determine the growth of an industry are, the availability of raw materials, labour and market. All these conditions are quite favourable in India so far the Ceramic industries are concerned. Yet we have not progessed much during the long period of about 40 year while other countries in Europe and America have made spectacular developments.

The ceramic industries have outgrown the stage when emperical formulas, secret methods of manufacture and the skill of artisans were the only sources to depend upon for success. Modern manufacturing operations must be based on proper scientific knowledge and economic technique.

Clay working in general is a greatly diversified craft with many variables and uncertainties. It involves problems of manifold nature dealing in the realms of civil, mechanical and electrical engineering, as well as the knowledge of ceramic technology and economics. It is therefore not possible to deal in a single volume all the aspects involved in this industry in detail.

Attempts have been made in this small volume to present in a concise manner some important aspects of this industry with data specially suited for Indian conditions, which formerly one had to seek in wide range of literature for which great deal of time and energy had to be spent.

A bibliography of available literature is given, but in many cases the author has used his data collected from various factories both in India and abroad, and expressed his personal opinion in the line based on his experience of last twentyfive years. At the end of the book the main sources of raw materials available in India for this line of industry are mentioned. The list is not exhaustive as search for these materials is still in progress and with the help of the Central and Provincial Governments it is very likely that many more new depo-

sits of clay, felspar, quartz and gypsum will be discovered in near future.

In chapter V some useful indications have been given for drawing up schemes of pottery works for various types of products suitable for Indian markets. It is needless to say that a complete scheme can only be drawn up after proper study of the local conditions, but it is hoped that students of ceramics will get some help from the data given in the chapter, which will enable them to draw such schemes when called upon by our capitalists.

Indian capital is not shy but proper men to advise and guide in this line are not available in sufficient number. Many of our old ceramic factories are still managed by emperic experts of old days, who are very reluctant to admit in their factories modern students of ceramics for reasons best known to them; and this lamentable condition is not only hampering the rapid progress of development in this industry, but it is also putting a setback to the practical training of our young men coming out of various ceramic training centres in India. A combination of both theoretical knowledge acquired in technical institutes and practical training in factories is very essential for our future guides in this line.

I shall deem my labour amply rewarded if this small volume is able to help in any way those persons for whom it is written—the young ceramists of to day, who are the future hopes of Ceramic India.

Before ending, I must express my thanks to my friend Sri Himangsu Kumar Bose M. Sc. for his various helps during printing this book specially in going through the proof sheets and giving suggestions.

November 1948. Hiren Bose

Benares Hindu University.

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CHAPTER I

LABOUR AND EFFICIENCY

The Factory labourers in India do not constitute a separate wage-earning class exactly corresponding to the Factory labourers of Europe and America where they form a permanent class by themselves completely divorced from land. This class of people is born in the cities surrounded by various factories; the modern machineries and labour saving devices are not foreign to them when they enter into a factory for earning their wages. The high efficiency of the foreign factory workers is to a great extent due to his early upbringing in a factory area The son in most cases takes to the work of his father and gets many informations in the line during his daily home life. He also inherits certain qualities of his father and becomes a better craftsman.

Ordinarily, the Indian factory labourer is drawn from the village. In almost all cases his hereditary occupation is agriculture His permanent home is in the village, not in the city like his foreign co-worker. He is not tempted by the lure of city life or by any great ambition. The city as such has no attraction for him and when he leaves the village he has seldom any ambition beyond that of securing the few necessities of life. Very few workers would come to the industry

if they could secure sufficient food and clothing in the village. It is no exaggeration if we say that half of our agricultural population never know from year to year what is to have their hunger fully satisfied. Indian factory workers mostly come from this hungry village population. It is the insufficiency of land and occupation in the village that pushes these village folks out of their village homes. They are not drawn to the city by any great ambition or temptation of better standard of city life. Even when working in a factory, the worker regularly returns to his village home to look after his affairs and to live with his family for sometime after the strain of his factory life.

In cities, the average Indian worker finds himself subjected to unaccustomed strain, both of body and mind, owing to disciplined hours of continuous toil instead of the spasmodic work with long intervals of rest which he has been accustomed to in the village. He is further demoralised by certain evils, comparatively unknown in the village, such as gambling and drunkenness. The environs of the mill or factory in India are not such as to enable a simple villager to maintain his moral character for a long time specially when away from his family.

The labourer does not rely exclusively upon factory employment in order to obtain a permanent livelihood. He desires ultimately to return to his village home where he regularly remits money from city. He is unable to develop any lasting interest in his factory

work. This indifference of Indian labourer has had a baneful effect upon the nature and quality of his work. He is irregular and unsteady, likes to take things easy. He has a distaste for discipline and dislikes confinement for long hours in the factory. These are the main reasons which prevent the average Indian factory workers from acquiring a high standard of technical efficiency. Mere increase in wages does not improve the matter always. It will not be out of place to quote a few lines from the address of Mr. N. C. Sarkar, Chairman, Indian Mining Federation; "we have known the bitter effect of an increase in wages, how it has failed to stimulate a desire for higher earnings and how it has acted as a direct incentive to increased idleness." The salvation of the Indian working class, in his opinion, lies in quickening the sense of better comfort and better standard of living.

But we should not be discouraged by the above mentioned conditions of Indian labourers; they possess a great adaptability. When our industries will be properly organised under modern conditions, a class of industrial operatives will grow up possessing the inherited skill and dexterity like the English or American workers. In his evidence before the Industrial Commission of 1919, Mr. T. W. Tutwiler, Manager of Jamshedpur Iron and Steel works said emphatically that Indian labour can be trained to replace almost every kind of foreign imported labour. If this was the situation in 1919, the present condition has

improved to a great extent which is apparent from India's magnificient productions during this great world war. The Indians had remained cold to the modern movements for industrial efficiency mainly due to the plentifulness of low-priced labour, the tropical climate, and religious attitude towards life, whereby poverty is readily accepted or even espoused This defficiency however is gradually becoming less due to the changed economic conditions and the present industrial drive for more production.

Although the inferiority of Indian labourer can not be denied, it is largely exaggerated. In his evidence before the Industrial commission Sir Alexander Mc. Roberts stated that the English worker was 3.5 times as efficient as the Indian. Sir Clement Simpson calculated that 2.67 hands in an Indian cotton spinning and weaving mill, are equal to one hand in a Lancashire mill. But it should not be forgotten here that the Indian mill owners do not employ the most up-to-date labour saving devices and machineries like the Lancashire mill owners. In India, all modern machineries are to be imported at a comparatively large cost; and the machineries wear out more in hot and dusty climate. Cheap labour is another reason why the mill owner is not so inclined to provide the latest type of labour saving device. He finds that although the number of workers employed by him for a particular work is greater than in other places, his ultimate cost of production is not greater, rather

less in many cases. This is why the mill owner of Bombay and Ahmedabad enjoyed such high profits after the first great war of 1914-18 inspite of the low efficiency of the Indian cotton mill workers.

It is also undoubtedly a fact that the general physique of the average Indian worker is inferior to that of an average English labourer. This is due specially to two main causes; the ravages of tropical diseases like Malaria, Kala-azar, Cholera, Typhoid etc. and poor dietary. There is probably much truth in the suggestion that the slackness of the Indian worker is a kind of protective device which he unconsciously adopts to prevent the constitutional breakdown which the strenuous labour for long hours would otherwise inevitably bring about.

Malaria is a great menace to India. About one and a half millions people die in India from this disease alone every year. Nearly an equal number suffer, specially in Assam, Bengal, north Behar, and some districts in the Punjab. Those who survive the disease, lose their health and vitality, and become an easy prey to other diseases. It has been proved beyond doubt that malaria is not infectious. Its germs are carried from man to man by special types of mosquitos and there is no reason why this country cannot also be made mosquito-free as has been done in Panama and in other parts of America, if a regular campaign against mosquitos is launched.

The malnutrition of Indian workers is the outcome of proverty and ignorance. Mere increase in the wages of factory workers will not remove this vital problem. The income and the standard of living of people living in the villages should have to be raised and they must be educated on the problems of nutrition and general hygiene so that they know how to get balanced diets in their daily meals and how to keep away the diseases. Our factory workers come from the village, so, unless the ravages of disease and the baneful effects of malnutrition are uprooted from the village folks, it is idle to think of better physique in Indian factory workers and expect greater efficiency of work from them. Better housing arrangement and sanitary conditions are sadly needed in most of the workers' colonies in India.

In his report for 1935, the Public Health Commissioner of the Government of India stated that a considerable proportion of the population in India revealed malnutritional conditions, due for the most part to qualitative defects in the ordinary diet of the people. No preventive campaign against malaria, tuberculosis or leprosy, no maternity relief or child welfare activities are likely to achieve any great success unless the vital importance of defective nutrition is recognised and given a serious attention. The first essentials for the prevention of disease, are a higher standard of health and a greater power of resistance to infection. These can only be attained

if the food is such as to give all the physiological and nutritional requirements of the human body.

When the causes for the betterment of the general physique of our industrial workers are attended to, the workers should be trained up under modern scientific methods from the very beginning of their career so that the efficiency of their work is improved. The factors which greatly influence the efficiency of labour may be summed up as follows :—

1. *Vocation*. Industrial workers should be selected according to their aptitude and given the job for which they are best suited.
2. *Time study*. It is essential to find out first the best method of doing a particular job and then train the workers to perform the work within the standard time set forth.
3. *Fatigue study*. It is very important, specially in hot countries like India, to determine the various causes for fatigue in human bodies and how to minimise fatigue in industrial workers so that they can produce more work.

Vocation. In a vast country like India, industrial works should be properly distributed and the workers selected from all classes of young men according to their ability and inclination so that they may take up an occupation in which they can give their best with real interest and joy in work. Personal discontent and industrial unrest proceed from an attempt to put square pegs in round holes. Physical and mental

ill health results from spending long years in an occupation which is utterly distasteful and unsuitable for one's mental and physical conditions.

It is a well known fact that many young persons change their occupation many times within the first two or three years of their career which leads to lessen efficiency on the part of the workers themselves and is uneconomic for the industrial concerns. The time and money spent on these rolling stones for their training in different jobs are wasted.These persons change their jobs because, either the work is not according to their taste or does not suit their physical condition of health. A thorough mental and physical examination of the workers is absolutely necessary for selecting the proper man for a particular job. For example, a young man who is quite intelligent but physically weak, should not be selected to work in the kiln house of a pottery works where he will have to lift heavy weights th oughout the day for filling and removing the articles in kilns. He may be better suited for the production machine if he likes the job. A man with a weak eyesight should not be trained as a fireman. A man with weak lungs should not be emplyoed for the grinding room of a Pottery or Cement factory where he is liable to contract "silicosis" easily.

Thus by proper selection of the vocation based on scientific examinations both physical and psychological, one can increase the output of work, lessen the industrial fatigue and mental unrest of the

workers. Heredity in this respect helps a good deal in shaping the mind of youngmen. A son of a carpenter naturally likes his father's job provided the father is contented with his lot. The boy is brought up in an atmosphere which he gradually begins to like and follow ultimately. He also inherits his father's skill. Similarly, a potter's son gets acquainted with the potter's wheel from his childhood and as he grows up he becomes well versed with all the methods and tricks of the wheel for shaping plastic claymass into different forms, an art which requires a new man a long time to learn. The great skill of some of our village craftsmen is mainly due to this inherited skill from father to son. The ancient caste system of the Hindus greatly helped in this hereditary efficiency of our craftsmen.

Mere selection of a young man for a particular vocation suitable for him is not enough for making him a skilful workman. He is to be trained in the technique of that vocation scientifically so that he can acquire the skill easily and do the job perfectly in less time than those workers who are not trained similarly. A pottery worker using a jigger will produce a greater number of articles per day from the machine if he is trained from the very begining how to handle it properly. To do his job thoroughly, he should also have a fair knowledge of the properties of materials he is handling daily. For example he should know why the clay articles crack in drying and firing due to bad workmanship so that he may take proper precautions to

prevent the same. A fireman of a pottery kiln must have a broad knowledge of what is going on inside his oven during the whole process of firing, otherwise he cannot manipulate his kiln successfully. It becomes a great burden on the shoulder of the factory manager if he has to instruct his workmen at every stage.

In a country like India where most of the workers are still illiterate, the training for the workers is best done in the factory itself where they will be ultimately engaged. Before a new man is allowed to take up a particular job he should be asked to go round the factory for 2 or 3 days and select the line of his liking provided he is physically suited for it. The foreman or sardar of that shop should then look after him and train him up in the job in the best way from the very start. Unless our present experts have a sympathetic bias towards their new workers it is idle to expect skillful workmen for the future expansion of our industries. The foremen and expert should be trained in polytechnic institutes supported by Government. These institutes should have attached model factories or workshops where the students can get best practical training and theoretical knowledge side by side.

Time study. This term implies the determination of the standard time to accomplish a certain job so that the workers may be trained to do it within that standard time. This determination of the standard time or time study, is as essential to economic management of a factory as the quantitative analysis of materials is to the

modern chemists. But this determination of standard ime is not so easy as the analysis of the chemist. In he latter case only inesrt materials are dealt with, while n the former case changeable human factors which liffer both physically and physiologically are to be considered. For this time study, Taylor's practice was o time first class workers who would be induced by ncreased remuneration to work as fast as possible and hen set the standard on the basis of their achievements.

C. S. Myres regards this procedure as unsound, scientifically, socially and psychologically. It is unscientific because there is no accurate data or information available on which the amount of allowance nade can be based. The working capacity of workers ilso differ with the change of climate and temperature n different countries. It is anti-social, as it aims at excluding as far as possible the average or slow workers t is unpsychological, as this measure introduces abnormal conditions which cannot fail to arouse an undesirable mental atmosphere throughout the factory vhich will ultimately lead to unrest and dissatisfaction amongst the workers But this method may be adopted or fixing the piece rates of new articles, with which the average workers must be timed as well as the fast vorkers. Unless there are some special inducements or greater output the average workers will not be nduced to put more efforts and increase their rate of production.

Rate fixing of pottery workers should very carefully systematise all the minor details in the running of each shop, such as the conditions of the machineries, tools, and equipments and the regular supply of the materials to the workers bench. In German pottery works, every Saturday afternoon is allocated for cleaning, oiling and adjusting the machineries so that they may run smoothly the whole of the next week. If proper machines and tools are not provided, the output of work will not increase inspite of all efforts on the part of the worker. An improved potter's wheel for example, driven by a boy assistant, gives much greater ease to the worker who can increase his output than when he works on an old fashioned wheel. A clay body pugged in a modern vacuum pug mill becomes so buttery in consistency that it works very smoothly in the moulds and a worker can produce much greater number of articles from this de-aired body in a jigger machine than he could do from ordinarily pugged clay body. Profiles are very important tools in pottery works and they get wornout by constant use. If these tools are not corrected as soon as they get deformed, the rate of production of articles will suffer and the wares will become faulty or may crack during drying or firing. Hence the rate of production and the wages for the same should be fixed after due consideration from all sides, human, machanical, and circumstantial. A long experience and great judgement are necessary to arrive at a satisfactory standard.

Fatigue study. It is not a difficult job to take care of the machineries, tools, and materials and to maintain a standard condition so that the process of manufacture may go on smoothly, but to keep up a standard condition of the human machine is rather a complicated affair. Like the clogging of machinery, the human system gets tired on prolonged work due to the accumulation of some products, in the nervous and muscular elements. These products are removed by the blood, partly by direct flushing, and partly by chemical changes in the tissue itself. It requires time to bring about these changes, and if sufficient time is not allowed, the capacity for work will gradually diminish which manifests finally in the form of fatigue in the human system. It has been found that the work of an individual becomes easy a short while after the beginning and the production gradually increases and finally reaches a maximum stage. After the period of maximum work is reached, conditions are pretty uniform for a time, and then a period of lessened output follows. Continuous work make the human muscles stiff, consequently the agility of the limbs is reduced and the progress of work is retarded. The muscles require rest to relax the stiffness and to regain the activity of the limbs. If the work is stopped for a short while when the fatigue gets maximum, to give rest to the human muscles, much greater output can be obtained at the end of the day than is usually produced by continuous work. It has been shown in a Bicycle factory, where the

period of work of some girl workers were reduced from ten to eight hours per day with rest periods of ten minutes each in the middle of the morning and afternoon shifts, thirtyfive selected girls could do the same amount of work that was previously performed by hundred and twenty girls. In Japan, Ceramic factories begin to work from 7 A. M. in the morning and close down at 6 P. M. in the evening. The midday recess begins at 12 noon and lasts for forty minutes. At 9 A. M. and 3 P. M. there are two intervals of 10 minutes each to enable the workers to take short rests and relax their muscles. So the Japanese workers work ten hours daily in the factories while workers in other countries work only eight hours and still the efficiency of Japanese workers is in no way less than workers of any other country.

Fatigue of human system is not to be compared with the failure of fuel as in a steam engine but rather with the clogging of the wheels of some mechanism by the accumulation of dirt. The problem of industrial fatigue, is primarily and almost wholly a problem of fatigue in the nervous system and of its direct and indirect effects. If the results of human fatigue advances beyond physiological limits which cause overstrain in the system, it will do both physical and mental damage of a more or less permanent nature. It is plainly uneconomical to allow this damage to be done.

The amount of fatigue in human body can be reduced to a great extent by scientifically regulating the motions of the workers. If a load has to be carried to a long distance, it is better to get it performed by a team of workers rather than by a single person. If a man has to go with a load for some distance he will get less tired if he takes periodic rests for a short while after his walk for a certain distance, than if he walks straight to his destination with the load on. The number of movements required to perform a particular job should be studied and brought to the minimum. Unnecessary movements on the part of the workers make him tired untimely and scientific control of this movements will help a great deal in reducing industrial fatigue. Let us take the example of a brick layer's boy in an ordinary brick yard. Every time he stoops to pick up a brick from the ground, he has to lift his own body, a weight of say one cwt. If at the end of the day he has lifted 1000 bricks, he has also unconsciously lifted up 50 tons of his own body weight, which is an achievement to make him tired at the end of the day in a hot country like India. If his movements can be reduced to half, the boy can perform at least double the amount of work daily. In digging earth or lifting coal, attention should be bestowed to the proper weight of the shovel and the size of its handle, given to the workers. The weight to be lifted in each lift of the shovel will contribute a great deal towards the fatigue of the worker which will ultimately affect the efficiency

of the work. Careful study to lessen the number of movements in designing new machineries, has improved the quality and increased the output in many cases. It has been found in practice that if a worker is given only one type of work to perform, he will produce greater number of the articles than if he is to make several types. In the former case he gets used to the movements of the machine and his limbs and performs them as if automatically.

Hot and humid atmosphere and lack of ventilation lead to fatigue in the industrial workers. When the air is hot but dry, the evaporation takes place from the surface of the body and there is not much perspiration in the workers. In highly humid atmosphere even when the temperature is not so high the worker perspires more and gets tired easily In a workshop where there is lack of ventilation, the heat generated in the bodies of workers due to brisk movements of the limbs would not get easily radiated if the humidity of the workshop is high and consequently the workers would get tired soon. When the body of the workers gets heated up due to active work or they begin to perspire due to high humidity, a mild breeze quickly cools down the body to normal condition. The cooling power of air mainly depends on the difference of the body temperature and the surroundings. Hence it is evident that in summer time, when this difference of temperature is not much, there should be an air current passing through the

workshop in order to get the same cooling effect as we get in winter when this difference in temperature is much greater. In hot countries like India, even in the cold season, a mild air current in the workshops is necessary in order to remove quickly, the body heat generated by brisk work and reduce fatigue in the workers. The velocity of air current in potters' shops in England was found to be 17 feet per minute in winter and 21 feet in summer. The average temperatures within these shops are kept at 70°F in winter and about 80°F in summer. These temperatures are considered to be about 10°F higher than in the workshops of other industries in England, like the Boot and Shoe factories and the Engineering works, where the operatives are engaged in more active movements as compared to the potters. The average outside temperature in Stoke-on-Trent, England, during the summer months from June to September ranges between 65°F and 75°F, whereas the temperature between October and February varies from 34°F to 65°F.

Contrary to expectation, the air in potters' shops in Stoke-on-Trent, was not found to have much greater relative humidity than shops of other industries in England. The humidity of air in the potters' shops at temperatures between 70° to 80°F amounted to about 58 per cent, and that in Boot and Shoe factories was 53 per cent, when the outside humidity of air between 8 A. M. and 5 P. M. in the day was 51 per cent in the months of July to September. The mean humidity of

cotton weaving shops varies between 70 to 74 per cent between the summer and winter months.

The temperature inside potters' shops in Central Germany is kept at 20°C (68°F) in winter and 30°C (86°F) in summer. It seems therefore that a temperature condition between 70° to 80°F is best suited to pottery workers in European countries; but the most suitable conditons for India have to be determind by actual experiments in different provinces, as the condition which will be suitable in the Punjab will not be ideal for Bengal where the average winter temperature is about 65°F. Air conditioning of factories and offices are necessary in those parts of India where the average winter temperature is much below 70°F and the temperature in summer rises much above 100°F.

Insulation of the building walls, will also help to a great extent to keep the temperature inside workshops under control. Specially made porous insulating bricks may be used for this purpose. Glass and mineral wools are now extensively used in America for insulating the walls of their factory buildings. In England an air gap of about an inch is left within the out-side walls of all buildings which serves as a protection from cold from outside. In India—cheap insulating boards can be made from asbestos, wood shavings, bagasee from sugar cane or wood pulp and used in our factories as insulating medium.

Efficiency Data.—Now let us consider some working data from pottery workers of various countries and compare their efficiency with our workers.

One girl worker in England assisted by another can make 90 to 100 dozens tea cups or saucers per day of eight hours, working on a jigger machine. The wages of girl workers in England was 9 *s.* 6 *d.* per day before the Great War of 1939.

One saggar maker in England can make 140 saggars per day by hand moulding. These rectangular saggars are used for tile placing. Size 14½"X 7½"X 6½" high and the man gets 12 *s.* 6 *d.* per day for the job.

One boy worker in Germany working on a jigger machine can make about 400 standard saggars of 3 inches height per day. The rate for payment is 1.2 R.M. per 100 saggars.

A pair of German workers helped by a boy or girl can make 3000 complete ordinary double cup porcelain insulators 6 inches high, on jigger machine per week. The wage of male workers in Germany is 6 R. M. per day and that of boys or girls 4 R. M.

In Belgium, Holland, and Czechoslovakia, the average wage of a pottery worker is 4 shillings per day.

In U. S. A. the minimum wage for workers in the clay products, glass, and allied industries is 40 cents per hour or 3.2 dollars per day.

In Japan the pottery workers used to get before the Great War of 1939 the following wages, boys or girls, 70-80 sens ; women, 90-100 sens and men 150-160 sens. But the Japanese workers work 10 hours

per day, whereas workers in other countries work only 8 hours.

In Japan, a man working on a jigger can make about 1200 cups per day of 10 working hours and a man assisted by a boy can make about 1100 saucers per day. For fixing handles on tea cups when both the cups and handles are in the biscuit state, a woman can do 1500 cups per day of ten hours work. In casting, a man can operate 60 moulds and can cast 6 or 7 turns per day or turn out 360 to 420 pieces daily.

The comparative figures for pottery workers in different parts of India are give below :—

In Calcutta the wages paid to Jigger men before the last war were from annas 12 to Re. 1, and to boy assistants As. 10 only. A man assisted by a boy could make 800-900 tea cups per day on a Jigger machine.

In Gwalior a Jigger man could make 600-700 tea cups per day and he was paid As. 10 per day.

In Cochin two boys working together, make 250 to 300 pieces of small bowls or cups on a jigger and jolley machine. They are paid 6 annas per day.

In a small pottery works in the district of Singhbhum in Behar, one man helped by another can make 80 to 90 small saggars of 8″ X 2″ size by hand pressing

The same pair can make 35-40 pieces of big saggar 15" X 3" size per day of 8 hours. The rate for the small saggars is $1\frac{1}{2}$ rupee per 100 pieces and for the bigger one Rs. 3/- for one hundred.

In Mysore Porcelain factory, the wages paid to the pottery workers vary from annas ten to As. 12. A jigger man in this work makes about 700-800 tea cups or saucers in each working day of eight hours. The dinner wares are made by a crew of 3 jiggar men and 2 finishers, who can produce 500 dinner plates per day. The rate is 6 pies per plate. In casting cups and saucers in the same factory one man can handle 60 moulds and cast 4 to 5 turns per day. Each man makes 300 cups per day but the number of saucers turned out is only 200 from every casting man. The rate for cups is 2 pies and that for saucers 3 pies each. Two workers working together can make 25 to 30 hand-made saggars of 16"X 6" size per day and paid at the rate of 5 pies each. Smaller saggars of 12"X 6" size are paid at the rate of 3 pies each and two workers can produce about 40 pieces daily.

To compare the working efficiency of pottery workers in different countries we can take up the production of tea cups on the jigger-jolley machine. In the following table the working cost is calculated from the wages of one worker only and the exchange value s taken as—

100 Sens=1 Shilling=12 Annas.

Countries	Production Man-hour	Wages Man-hour (in annas)	Cost per 100 pieces (in annas)
England	150	14·25	9·5
Japan	120	1·8	1·5
Calcutta	112·5	2·0	1·7
Mysore	100·0	1·5	1·5
Gwalior	87·5	1·25	1·43
Cochin	37·5	0·75	2·0

It may be mentioned here that the pay role in modern pottery works comes up to about 55 per cent of the total cost of production and the efficiency of workers is a very important factor in this respect.

The production efficiency of average Indian worker is behind other industrially advanced countries. The wages of our workers before the last world war were also very low, hence the total manufacturing cost was sufficiently low to compete with the manufactured goods imported from the foreign markets specially the inferior quality products.

After the last war, the general trend of higher wages for all workers has come to such a stage that unless our workers increase their production efficiency both in quality and quantity, it would be difficult for the Indian manufacturers to compete with the foreign imported goods and sell their articles in the open home market.

It is not a safe or wise policy to protect the home market with tariff duty indefinitely. The policy is helpful for the growth of infant industries but not healthy for the proper development of industries in a free country. The extra duty is ultimately paid from the pocket of the consumers of goods. The manufacturers and workers on the other hand indulge in slackness and fail on their parts to increase the wealth of the country.

The Indian labour leaders who encourage the workers to go on strike for higher wages and better facilities, should always bear in mind that it is their moral duty to induce the workers for greater production also. For this purpose better training of the workers on modern scientific lines is very essential and it is the duty of the Government to see to this.

There is a general cry all over India for full mechanisation of our industries to lower the cost of production. Should we accept this general cry for the pottery industry as well? Indian pottery of the present time has not reached the standard in quality of other countries. Future mechanisation should therefore aim at the production of better wares rather than cheaper wares as, Indian pottery is already cheap.

The population in India has already reached a stage when our agricultural lands have become insufficient to provide employment to our people as before. We now need more employment for our men

in industries to provide them with food, clothing and shelter. Indiscriminate mechanisation will curtail the number of human workers employed in industrial enterprises. Besides, full mechanisation is high in capital cost and the only way to reduce the capital overhead percentage is to work the machine for long periods.

An outstanding example of full mechanisation in pottery industry is the Scio Pottery of Ohio ; (*The Ceramic Industry* Nov. 1942), This pottery pays the highest wages to its workers in the world and at the same time can compete with Japanese pottery in the home market. The factory works for twenty four hours in four shifts of six hours each and the work continues for the whole week of seven days and the full year.

Without going into the discussion on the effects of this type of continuous work on the social, moral and physical reaction on the workers, one is inclined to ask, does America import pottery wares ? The people of America inspite of their cheaper home products,buy English pottery for their beauty, craftsmanship and tradition. Pottery wares of China, Japan, England and some other European countries have made their mark owing to the traditional craftsmenship of their workers and not by mechanisation only. Indian potters are quite skillful and they can also build up a tradition for their design, decoration and craftsmenship if they are properly guided by the modern scientifically trained experts.

The solution of the problem therefore, would be in dividing the industry in two groups. The one for the manufacture of pottery wares of the highest quality, beauty, shape and colour, following Indian art and culture. These wares would be catered to the select or high-priced market both at home or abroad. This group or section could adopt mechanisation to some extent as would make for better quality of wares and improve the general working conditions. Full mechanisation in this case would prevent the amount of variation and flexibility required for good craftsmanship and quality production.

The other group or section may manufacture the standard quality wares in large amount and at a cheap cost for meeting the everyday requirements, for the home market and for export to the neighbouring countries where they do not make pottery in sufficient quantities to meet their own demands. This group can mechanise to the full extent. Mechanisation should be adopted to raise the standard of quality and not for the sake of lowerering the cost alone.

CHAPTER—II

BUSINESS ORGANISATION

It is often said that Indian capital is shy, that though there is no dearth of money in India still Indians in general are not industrial minded and do not like to invest their surplus money in business. This statement may be partially true, but industrial magnates like Martin, Tata, Birla or Dalmia will tell us that there is plenty of capital in India awaiting investment in industrial securities, but there are not many companies whose shares can be purchased, i. e. companies in which people may have sufficient confidence. The sound financial position of a party depends on his success in the past and in his prospect in the future. The success of a business depends on its nature and object and on the honesty and efficiency of management. The ability of the promoters in selecting the right type of business and the right place are very important and vital to its success.

In the early part of the present century, during the Swadeshi movement of Bengal and after the Great War of 1914-18, many manufacturing concerns were started with money raised by public subscriptions and there was no dearth of capital, but most of these enterprises were hastily concieved, ill planned

and inadequately financed with the result that in many cases the concerns failed before the operations were started, and in others, after a few years of unsuccessful struggles. The memory of the losses suffered by some of the investors in these concerns still rankles in their mind and naturally they find it difficult to differentiate the good from the bad investments and decide not to purchase shares of newly started companies promoted by inexperienced persons. These investors prefer to keep their surplus money safe in bank or buy Government securities. Those who have not suffered losses are not unwilling to invest their money in industrial concerns and this will be evident from the fact that in 1935, India had 9261 large industrial establishments of all kinds employing more than 1.84 million persons.

When the capital is organised, the promoter of a business should secure properly trained experts for his manufacturing concern. The manufacture of commodities in modern times has been divided into a number of processes. Each process requires an expert's knowledge and it is not possible for one man however clever he may be, to become expert in all of them. In the regular process of manufacture innumerable difficulties may arise from time to time which can be solved or removed by experienced men only. A few years' training is not at all sufficient to overcome these difficulties. This is one reason why many of our factories suffer losses

because they depend on men who have only a few years' training in a foreign country. It is much better to import foreign experts when and where necessary, for a fixed period on the understanding that they will train our people fully before they leave.

Selection of the proper type of industry which is likely to yield profit, is a matter of great importance to the promoter of any new business. He must make sure at the very beginning that the article which he is going to manufacture will have a ready sale in the country, that all the principal raw materials are within easy reach, or can be brought into the proposed factory area without much difficulty and that trained labour for the purpose is not scarce. There should be a good demand for the article by the genera public so that the products of his factory may not have to be stored for long periods.

Ceramic products, i. e. articles made from clays like bricks, tiles, pottery, porcelain, glass, cements etc. have a ready and continuously increasing demand in India. The present production of these articles in India is not sufficient to meet the minimum requirements. The extent of the demand of various types of clay products can be estimated from the following import figures from the year 1932 till the beginning of the war of 1939.

VALUE IN RUPEES OF IMPORTS INTO INDIA OF VARIOUS CLAY PRODUCTS

Year	Earthen ware and Porcelain	Earthen. ware Pipes	Bricks and Tiles	Electrical Porcelain
1932-33.	4815394.	5902	1361283.	134739.
1933-34.	4246443.	8595.	1328340.	59879.
1934-35.	4296045.	4521.	1223822.	125222.
1935-36.	4423930.	3047.	1630482.	170307.
1936-37.	4517083.	2620.	140809.	142576.
1937-38.	4779747.	1267.	1598772.	... ...
1938-39.	3919205.	... ...	1601040.	... ...
1940-41.	3041000.	... ...	... ...	... ...
1941-42.	3512000.	... ...	... ...	... ...
1942-43	1074000	... ...	... ...	... ...

Before the Great War of 1939, there were hardly a dozen big factories turning out in India white pottery wares. The total number of persons employed in the pottery and cement factories in the year 1935 was estimated to be about 1300 only and that for making bricks and tiles, 1500. In the Glass Works of India about 7000 hands were engaged in 1935.

As the country gets more industrialised in the near future, the demand for electrical porcelain will increase to a very great extent. The trend of this increase can be observed from the import figures since 1935. With further expansion in the modern system of housing and sanitary arrangements in the bigger cities of India, demands for heavy clay articles like commodes, urinals, wash basins, glazed wall tiles and pipes will

also increase. It may be noted here that foreign competition for these heavy clay wares is comparatively much less than that for lighter hollow wares like crockeries and table wares. The systematic increase in the import values of China and porcelain wares since 1935 proves clearly that Indians are getting porcelain minded gradually but there are not sufficient number of factories in India to cope with even the present demand. The manufacture of refractory bricks and blocks for our industrial furnaces has also a very bright future.

All raw materials necessary for making high class porcelain or china wares sanitary wares, glazed wall tiles, salt glazed pipes and special refractory bricks for modern high temperature furnaces are available in India in good quantity. Some of the valuable refractory materials like Sillimanite, Chromite, Magnesite, Zirconia etc., are now exported and we import the finished goods made from these materials. The high import values under the head, Bricks and Tiles, clearly indicate this fact, as *bricks* mentioned under this head, are not common building bricks, but refractory bricks for industrial furnaces and kilns. Trained labour for manufacturing all types of clay wares is also to be found without much difficulty ; experts for guiding the manufacture are not scarce now-a-days due to the training centre opened in the Benares Hindu University, since 1932 and due to the facilities opend to our young men now for their practical training in the existing

pottery factories of India. A large business concern owes it to itself and to the country to take a genuine interest in the training of our young men, so that when the opportunity arises they may be ready and able to take charge of responsible jobs and handle them properly. Consequently, in all our arrangements and plans of big factories, we should never neglect to make things as easy as possible for the beginners. In schools and colleges our young men learn from books and in the factory, from life. The first is all theory and second all practice. Both have their limitations. Only he who knows enough about practice to test his theories can call himself a real expert. It is not so much knowing a whole lot, but knowing how to make practical use of what you know that counts for the success of a business. Although it is true that it is not in mortals to command success, yet it is no less true that he who deserves success generally attains it.

The success of a factory largely depends on the efficiency of the organisation at the start. The essential factors that are to be considered before a factory is started may be summed up as follows :— (a) Capital, (b) Suitable site, (c) Labour facility, (d) Supply of raw materials and (e) Market facility.

Capital of a company is divided into three parts ; Blocked Capital, Liquid or working capital, and Reserved capital. The blocked capital is needed for the purchase of land, construction of buildings, purchase and erec-

tion of machineries and for the equipments tools etc. This money, when once spent for the respective purposes does not yield any profit, it rather depreciates in value every year. The buildings, machineries, tools and implements do not last for ever. Each of these materials has a definite period of life after which it becomes useless. So money spent after these items is wiped out after some time. Hence great care should be taken in spending this money. The amount of land, building space and the nature of buildings should be very carefully considered in the scheme of the factory, and no unne cessary money should be spent on these items. The selection of the proper types and amounts of machineries are items which must be left to the judgment of experts having long experience in this line. It has been found in many cases that for the want of proper selection of machineries the factory could not prosper in the past and it will be more evident now, when the race for competition is so keen. The oldest pottery factory in India had fallen into evil days for want of judgment of its directors. During the great war of 1914-18 they built five big Dresden kilns with three storied concrete buildings spending the greater part of the capital of the Company. When the war was over, Indian Govt. stopped its order for the supply of porcelain articles from the Company. The administration of the company became top heavy due to a large blocked capital and maintainance cost while the competition in the market became very keen owing to heavy

foreign imports after the war. To tide over this difficult situation, the Company had to reduce its share value to one fourth and had to borrow fresh money to run the business.

Liquid capital is the money required to run the factory from day to day. It is used to buy the raw materials and fuel, to pay the wages of labourers and office staff; and to meet the costs of advertisements, insurance etc. In the estimate of the capital of a factory, liquid capital should be calculated on the basis of at least six month's expenditure. Wholesale dealers receive articles from factories generally on one month's site but they actually pay up after three or four months, sometimes even later, so that if this liquid capital is not based on a wide margin, the easy flow of the manufacture may suffer. Many smaller concerns have come to grief in the past for want of this liquid capital. in a new industry, the first year is often spent in experimenting with the raw materials and standardising its products for the market. In such cases there should be an extra item in the estimate of the capital under the head, cost of experiments. In big towns where raw materials can be purchased easily or obtained on credit, the liquid capital required may be much less than in factories situated in smaller towns or in villages. In the latter case, stocks of raw materials, tools and implements, enough to last for several months, should be kept ready in hand or else the work may suffer even for the want of a single material. For pottery

works, materials like coal, clay, felspar, quartz, gypsum and chemicals, should be in stock in sufficient quantity but not in large excess, as the money blocked in this stock does not yield any profit. The wages of the workers to be paid weekly or monthly, should always be kept ready in hand. If regular payment is not made, the workers get dissatisfied and the production will suffer.

The reserve capital is the money kept in reserve in a bank under such conditions that it may be utilised by the company whenever necessary. This money bears a small interest. It has been found in the past that unforeseen disasters beyond the control of man sometimes crop up in factories or business and unless there is a reserve fund to draw upon for tiding over the difficulties, the business may collapse. It is difficult, or rather impossible to foresee or imagine the nature of such disasters which may ruin a business concern. An example of such a case is given below. In a big city in Behar, a tannery was started on the bank of the river Ganges on the site of an old indigo factory. The business was running quite smoothly for several years. One year during the rainy season the river was in spate, as usual, but suddenly the water level rose so high that the whole factory and its compound was flooded. There was no such high flood within the memory of the local people. The flood lasted for nearly three days but it took about a fortnight to remove the silt, to dry the floors and walls of buildings and clean the machineries for regular

work. The result was that all hides and leather in stock or in the process of manufacture, got spoiled. The company did not have a large working capital or any reserve fund so that after a brief struggle the business had to be closed down. The amount of this reserve fund would of course vary with the type of article manufactured, but for pottery wares, an amount equivalent to three month's working capital should be laid aside as reserve fund. As the reserve fund also helps in future expansion of the business, it is necessary to increase the amount gradually from the annual profit of the company. As buildings and machineries become older and tools and implements get worn out, they need periodical repairs or replacement. Hence a certain amount of money from the annual profit of the company should be kept aside as depreciation fund, in order to enable the management to draw upon it whenever necessary. The amount to be set apart on this head is based on the average life of each machine or tool under normal working condition which has been discussed in a later chapter.

Factory Site. The success of a business depends to a great extent on the proper location of the factory. Hence the organisers should select a suitable site for their factory after considering the various points discussed below. It is said that the first glass factory in India built at the foot of a hill in Rajpur near Dehradun, failed mainly for the wrong selection of the place. The organisers of this ill-fated glass works cared more for

the comforts of the imported foreign experts who wanted a cooler place, but did not consider the more vital problems like the availability of raw materials fue and labour facilities. The place was neither connected to a railway nor had any quick transport service to bring the raw materials from a distance or send the finished products to the selling markets. In selecting the site of a new factory all these factors must be considered carefully at the very start. The price of land should be cheap so that a large sum of money is not blocked up in land alone. There should be ample facilities for future expansion of the factory without great hindrance of any kind. In a city, the municipal laws restricting the construction of furnaces and chimneys and expansion of buildings and sheds, should be considered in advance. In England most of the big factories are constructed on the outskirts of big cities, but in Germany and other European countries big factories are often found in small villages. In the latter case there are facilities of cheap and quick road or river services, or the factory has a direct railway connection. A village factory enjoys the facilities of getting cheap labour and there is no need of building houses or barracks for the workers as is often needed for urban factories In villages, the workers live in their own home with their families and many evils of urban factory workers are eliminated. In German village factories both husband and wife can work. The women are let out half an hour earlier before the usual midday recess so that they can

go home and prepare the meal for their husbands and children. It is not always possible to get all the facilities for a factory situated in a particular place, but if we get cheap land and labour facilities from a particular site which is connected by railway to places where raw materials can be had, and to send the finished products at not an exorbitant cost, we can select that site for starting a factory specially for light pottery wares. For heavy articles, the cost of transport, both of raw and finished goods, should be considered in selecting the site. When the U. P. Glass Works was started at Bahjoi, a small place in the Aligarh line, there was no other special attraction than cheap labour, land and packing straw for the fragile glass wares. But the place is connected with a railway which enabled the management to obtain sand, lime, soda and coal from different distant places and send the glass wares to selling markets. The factory has expanded greatly in recent years.

An organiser who wants to start a new pottery works would be well advised to consider the following factors before he finally selects a site :—

(*a*) Topography of the land,

(*b*) Available drainage with ample outfall,

(*c*) Ample water supply suitable for pottery works.

(*d*) Good access from main roads and possible railway siding.

(*e*) Availablity of electric supply,

(*f*) Any local or official restriction imposed on the site.

The land selected should be sound for heavy construction and should not be a filled-in plot which requires large extra cost for a sound foundation. The possibility of mining subsidence should also be considered in case there are mines about the site selected. The sad plight of a large hosiery works in Jharia in Behar is too fresh in our minds. Due to mining subsidence the whole works went underground and the ill advised proprietor of the factory also lost his life along with his property.

It is often asked by the organisers whether the factory site should be selected near the main selling centre or near the sources of raw materials. This knotty question can only be decided after considering the following :

To fire one ton of white clay pottery wares, about one and a half tons of coal will be needed. The loss in weight in the wares after firing is about eight per cent. Taking two per cent more loss in material for making and ten per cent in breakage we get only 0·8 ton of finished articles per ton of raw body and 1·5 tons of coal used. To send the finished goods to the selling markets about 25 per cent more weight should be added for packing and the crates. Thus we see that in order to send one ton of finished articles out of the factory one has to import 2.5 tons of materials including coal. Above this, the fire clay for

making saggars and gypsum for making moulds are to be imported into the factory. If there is no electricity near the proposed factory area, more fuel such as coal or crude oil will be required for generating the motive power for driving the machinaries. The rate of railway freight for finished goods is always higher than that of the raw materials or coal, and the latter commodities can be obtained in full wagon loads where the rate becomes cheaper. All these factors should be very carefully considered on the basis of the monthly production of the factory unit. It has been found that factories situated within or on the outskirts of big cities like Calcutta, Bombay or Delhi enjoy the facilities of easy delivery of finished goods without the packing cost and less transport charges for the same; but factories away from such big centres are better placed when they are near the supply of chief raw materials like coal or the clays.

Labour Problem. The facility of obtaining labourers for the factory is one of the vital problems for the organiser, because the efficiency of a factory depends largely on a group of properly trained labour. In starting a ceramic factory in a particular site the organiser should see that workers of the proper type are available near about the place. Potters in India constitute a definite caste amongst Hindus, and it is difficult sometimes to induce people of other castes to take up pottery work. In some places, as in Gujrat district in the Punjab, pottery work is done mainly by the Muslims,

and the Hindus are very reluctant to take up this job. In places like Chunar and Khurja in the U. P both Hindus and Muslims do the potters' work and it is easy to get workers from both the community. It is better to employ workers for pottery works from people who are potters by profession as these workers possess some hereditary instincts in the line and can acquire any new technique more easily than average workers. It is not very easy to get a skilled operative outside his district without some definite terms of employment. Even in England potteries outside the district of North Staffordshire often find difficulty in getting skilled labour without some attractive terms.

In any case sufficient number of men must be available in the locality willing to work in potteries who can be subsequently trained for particular jobs. It is sometimes found necessary to import a few skilled labourers from other places when a new factory is started, but unless able-bodied, intelligent and willing men are available in the locality it is not possible to run the factorv smoothly and economically. When the first porcelain factory was started in Calcutta, a few Japanese had to be brought in to train the the local workers in the new technique. Local people do not join in labour strikes so easily as imported workers, and it is always pruden t to engage labourers from more than one class of people.

Supply of Raw Materials. Utmost discretion is needed on the part of the organiser in respect of the

supply of raw materials to the factory. The materials must be available not only in sufficient quantity but also at a cheap rate. These conditions may be secured by locating the factory as near as practiable to the sources of supply at the same time taking into consideration other factors like transport facility, labour, motive power and marketing of the finished goods. For Ceramic factories, coal is the chief material to be considered first. Next comes kaolin for pottery, sand for glass work, limestone for cement factory and chemicals for enamel works. If suitable clay is available from places, not very far away, the coal producing areas in India are the best suitable sites for starting clay works. In this connection it may be noted here that coal containing high ash content or sulphur is not suitable for pottery purposes. The ash injures the furnace lining and the sulphur spoils the glaze and colour of the pottery wares.

In south India most of the ceramic factories are situated near about the clay-pits as coal has to be imported from the distant Provinces of Bengal, Behar or C. P In northern India most of the big ceramic factories have to work their own clay mines as there is no other source of getting a regular and dependable supply of clays. This difficulty should be removed by establishing in different provinces of India, several centres for supply of ceramic raw materials of uniform quality at moderate prices. In England, Germany and other European countries, the pottery manufacturers

do not have to bother much for the supply of raw materials and hence they can devote their whole attention to other problems of the business. Unfortunately, the condition in India at the present time is quite different and the factory manager is more concerned with the supply of raw materials, than for manufacture itself. In Stoke-on-Trent in England, the organisation for supplying potters raw materials has developed to such a state that most of the pottery works there do not have to grind their flint or stone in the factory. These materials are readily obtained from the central grinding mills in the specific fineness required by the buyers. This type of organisation is very helpful in running a pottery smoothly, and to reduce the cost of buying heavy grinding machinaries in each and every factory. Small ceramic factories can be started in various parts of India if such organisations are formed to supply prepared bodies, glazes and colours for various types of pottery wares.

Selling Market.—In a country like India where the transport facilities are not properly organised or even modernised, the manufacturers of fragile goods should not stay very far away from the selling market so that the cost of packing and sending the articles to the prospective buyers may not be very high. Articles like glass, porcelain and hollow pottery-wares are fragile and inspite of very careful packing, they are often found to break in a long transit. The extra cost of packing of these fragile goods in a big factory is

an item which should not be neglected. The cost of transit also puts a restriction on the sending of the goods to far away markets. The Bombay and Ahmedabad mill owners find that imported African coal is cheaper to them than the coal from Behar or Bengal fields due to long distance and high Railway freight. A factory situated in a certain place can send its goods within a limited area, beyond which the cost of transit becomes so high that it often becomes difficult to compete in price with other manufacturers within the country or with articles imported from outside. Competition with foreign imported articles become more keen near a port town and as we go farther from these seaports the competition becomes less keen. For this reason small factories should be situated away from the sea-ports and in such places where the products of the factory may largely be consumed locally.

Advertisment. The success of a factory depends mainly on the rate of sale of the articles manufactured. To be more precise it may be said that the successful manufacturing of an article contributes only 25 per cent towards the success of a business, while the remaining 75 per cent solely depends on the sale of the article. It has been definitely established that a regular sale of any article can not be maintained without the help of scientific advertisement which creates demand for the articles that were either unknown or unrecognised in the new buyers' circle.

Regular advertisement creates demand in two ways. It makes the article advertised, familiar with the buyers, and it creates demand amongst those who did not use the article before. An advertisement may or may not bring immediate sale, but it prepares the customers to buy the article when needed, by familiarising them with the name of the brand, its special qualities and advantages offered. If a new factory begins to manufacture red clay wares from a local clay and with a good acid resisting glaze which is much superior to the red clay wares found in the market, and regularly advertises the new ware clearly explaining its superior qualities and advantages, it will eventually help to rouse interest with the buyer and succeed in inducing him to purchase the new pottery whenever he may require, although he was against using the old type red clay wares previously sold in the market. The merits of the new product must be fully displayed through advertisements and propaganda. The effects of large scale advertisements and regular propaganda of the Indian tea and coffee cess committees are well known to us. Not more than 40 years ago, tea was thought to be a slow poison to our system and very few people would risk its use, and coffee was quite unknown to the general public in northern India. To-day there is hardly any house in the cities or in most of our villages where tea or coffee is not used.

It has been observed in many cases that the rate of sale of a well known article varies directly with the

extent of advertisement made for it. The sale drops down no sooner the advertisement is slackend and rises again when advertisment is increased. Scientific advertisement by manufacturers has now expanded to such an extent that the dealer of the goods or the shop keeper is no longer the person to advise the average customer, but in most cases the buyer comes to the shop having already made up his mind as to what make or brand he should buy. The result is that average shop keepers find that it is more advantageous to stock the articles that are largely advertised than those of unknown or less advertised brands. The buyer gets his information about the quality and usefulness of the article he intends to buy from the elaborate advertisements given by the promoters of the article and before he goes to a shop he has already decided upon the brand he would buy.

Advertising is thus an investment, rather than an expenditure. The goodwill which is built up gradually by regular advertisement is frequently of inestimable value. Hence it is erroneous to believe that advertisement means increased cost of the article for which ultimately the buyer has to pay. On the other hand, regular advertisement creates greater demand of the article which the manufacturer can make on a mass production scale at a relatively reduced cost. He can also reduce the sale expenditure by getting rid of the middle men or the wholesale dealers, or reducing the trade discount. One very important point to be remem-

bered in connection with the regular advertisement campaign is that the article advertised must be of good quality in order to achieve success in the long run. The promises given in the advertisement regarding the quality of the article must be fulfilled. Satisfied buyers are continuous advertisers as they continue to recommend to others.

A successful advertiser should be gifted with exceptional power of observation in order to enable him to note current events and take full advantage of them. He should know how to make his advertisements attractive and effective. The introduction of oriental art in the advertisement pictures based on the famous Ajanta paintings has given a new turn to the Indian school of advertisement. It surely appeals to the sense of beauty of the educated class and attracts the people by its new designs. The first object of a scientific advertiser is to give his matter a good display so that it has the power of attracting attention. The display value of an advertisement is increased by several methods such as by pictures, coloured designs or borders, attractive head lines or slogans, neon signs, flood light, etc. The new method of advertisement by writing on the sky by smoke from an airplane is a novel and very attractive one for all classes of people. Although such advertisements are short lived, they leave a lasting impression in the minds of all, young or old.

When a new article is introduced in the market or when the prejudice of the customers against the old type

has to be overcome, the advertisement must be instructive and educative. Thus, in introducing a new tooth paste the advertisement should contain in brief the science of cleaning the teeth and the gum, and the hygienic value of its daily use. The deep rooted aversion against the use of China wares and enamelled iron wares among the orthodox Hindus can be removed only by systematic and educative advertisements and propaganda. It should be made clear to them that we no longer use bone ash for making our porcelain or enamelled iron wares, unlike some imported wares of foreign origin. Once the orthodox section of Hindus is convinced of this fact and begin to buy these country made wares, we can imagine what a huge demand it will create for our porcelain and enamelled wares.

Scientific advertisement as we know now, is intended for securing more sale, and increasing the profit of a business. The cost of advertisement, should therefore be taken as a part and parcel of the manufacturing, like the overhead charge, the insurance cost etc., and it should be decided on definite informations. It is however impossible to lay down any hard and fast rule as to the percentage of this cost based on the value of turn-over in all cases, because the circumstances differ with different types of articles. Besides, the amount which may be quite satisfactory for an established article may be inadequate for the purpose of pushing a new article in the market. For instance, in the case of a motor car company, one per cent on

the value of the car may be found quite satisfactory for the purpose of advertisement but for pushing ceramic articles in the market even ten per cent on the value of the article may not be sufficient.

In connection with every advertising proposition the proportion of cost for advertising must be calculated on the merit of the case itself. One method of doing this calculation is by basing the percentage of advertising cost on the past total sale ; whereas in another method the estimation is done on the basis of anticipated sale of the current year or for a period of years to come during which the advertisement campaign is to be carried on. The first method, though safer is not applicable for a new commodity. The second method is rather risky.

No doubt experience alone can give the best figure for advertising cost in a particular case but the basis of calculation can be formed from the following factors :—

1. Type of the articles to be advertised; whether old or new to the market,
2. Object of the advertisement ; whether for display alone or an educative literature,
3. Market of sale ; whether amongst common people or for the selected few,
4. Condition of market , whether there is competition or not.
5. Capacity of the factory

4. Condition of market ; whether there is competition or not.

5. Capacity of the Factory.

A pottery works making common table wares need not spend much in general advertisments, rather it should get in touch with the merchants who deal in this kind of products and whose business is to push the sale, provided the products are of good quality. There are not many factories in India making white sanitary wares, so a new factory making this class of wares should inform the public by advertisements or leaflets about their new enterprise and the size, shape and quality of the products. There is no chemical porcelain factory in India and the factory trying to place this new commodity for the first time in the market will have to strive hard in order to push its products against the imported ones which have already established their reputation. The cost of advertisement of this new type of wares should be carefully considerd with other items of costs in the very beginnig.

The object of advertisement of this new chemical porcelain products is to inform the specific users of this class of wares, like the school or college laboratories and research workers only. It would not pay to advertise this kind of articles in posters, sign plates or newspapers, but informations published in scientific journals will produce better effects. Instructive leaflets may also be sent to all school and college laboratories who are the biggest consumer of these articles and to establish the confidence of the new buyers, some opinions and certificates from reputed scientific men will be

helpful if inserted in the advertisement or leaflets. Genuine certificates from reputed men who understand the nature and quality of the products help a good deal in creating confidence in new buyers and for pushing a new product in the market.

The demand of all types of ceramic goods is so great in the Indian market specially after the last world war, that it is hardly necessary to give large scale advertisements, but it is always prudent to inform the buyers with some type of advertisments or literature about the availability of a commodity whether old or new in the market.

If a factory is small, it is no use advertising intensively and create a large demand which cannot be met with, and advertisement in that case would go against the reputation of the factory.

Show room. A well designed show-room is an essential factor for a modern pottery works. It serves as a source of advertisement of the nature of products manufactured by the concern. The show-room should display the wares in such a manner as to enhance their beauty and not overshadow them with other decorative objects. The prospective buyers on entering this room must have an impression of—What beautiful pots ! The display should be so arranged that differnt designs of pots and patterns are separated from each other and lights should be so arranged as to prevent the dazzling effect. Cheaper articles should not be placed with the costlier ones, they are better be segregated. In fact an artist's touch is needed for the effective display of pottery show room specially where decorative articles are used.

CHAPTER III

PLANNING AND CONSTRUCTION

Organised planning is said to be the crystallisation of desire into action. Before construction of a factory, a well designed plan should be made on paper showing the full datails of the flow of materials from the raw to the finished state and the respective positions of different buildings sheds, machineries and furnaces etc. This plan can only be made by experienced chemical engineers helped by construction engineers or architects, whose knowledge and experience in the particular subject enable them to work up a modern economic arrangement with the minimum mistakes.

When a man builds a house he employs an architect who works according to a previously made plan. The construction of a new factory involving buildings, sheds and furnaces etc, is a vastly greater and more complicated work for which a previous plan should be made giving all necessary details for the guidance of the engineers and architects. No single individual can have sufficient experience and knowlege to ensure success without the co-operation of other people. Hence help of experts is essential to draw up a successful plan.

In factory planning, provisions should be made for future extensions without tearing out the already

built parts or disarranging the existing machineries and disturbing the flow of materials in the working process. There should be sufficient but not excess working space for easy movements of the workers, ample light and good ventilation, so that the workers do not get tired easily which ultimately conduces slackness in production and loss in business. This fundamental defect can be observed in many of our old factories which were constructed without any conception of future extention.

The advantage of a well lighted work-shop is very well marked and is a stimulus to the workers against the depressing darkness of an ill-lighted room. Insufficient light tells on the eyes of the workers which ultimately affects the quality and output of work. Badly lighted workshops increase the number of accidents and the workers decidedly deteriorate in health. The direct entry of glaring sunlight is also not helpful to the workers. It will amply repay the cost, if the workshop is properly ventilated and shaded to ensure comfort and the necessary cooling effect needed for the workers. In case of artificial lighting, the lights should be distributed throughout the workshop in such a manner and at such intervals that sufficient and uniform light is thrown over the working benches without having undesirable shade anywhere. For performing detailed work on a particular job the light may be directed upon the work, direct from the lamp with a shade to screen the light from the workers' eyes. In a mechanical shop incan-

descent gas mantles should be avoided, as the constant vibration of machinaries is liable to cause mantle trouble. It also causes fumes, heat and flickering of light. It is a false economy to limit the supply of lighting facilities in a factory.

The effects of ventilation and temperature control have been already discussed in a previous chapter. In every room of a factory, sufficient means of ventilation must be provided and maintained for admission of fresh air and removal of impure air. The ventilation must be such as to render harmless as far as practicable, any gass, vapour, dust or any other impurities that may be generated in the workshop. Uuder normal conditions the air inside the room should be changed completely at least six times per hour. The factory room should not be overcrowded with workers. According to English factory rule, there must be in each room at least 250 *cu. ft.* of air space for each person. Temperature within the workshop should be kept between 75° to 85°F for the efficient work as has been mentioned before. This is done by properly, air—conditioning the rooms with suitable apparatus and insulating the building walls.

If everything connected with a factory construction is put in a well designed plan, a great deal more can be seen on the paper than is possible to see in the factory itself.

In preparing the plan of a new factory, the first step to be taken is to collect the informations of the latest devices for all the processes involved in the

manufacture and to make a flow sheet. Then chalk out the route of metarials through the factory from the begining to end of manufacture, by the most direct path moving the shortest possible distance. It should be borne in mind that it costs money to move articles whether by human agency or by power devices. Money saved in this direction may be a good part of the profit in the end, specially in a large factory. In all large factories where movements of large amount of materials are involved, mechanical conveyors are provided to reduce the labour charge or minimise the cost of movement. In American cement factories, they have perfected this system to such an extent that the total human labour needed to produce one ton of cement is 2.1 man-hour only. The consumption of power for each ton is 90 kw.-hour.

Another factor not less important in designing a new factory is to see that the raw materials which come to the factory are delivered very near the places from where they are to be used directly. Coal, for example should be unloaded near the boiler house or the furnaces so that least amount of labour may be necessary to carry it for use. In a pottery factory, felspar, quartz, gypsum etc, should be delivered near the grinding shed, and the kaolin and fire-clays to their respective bins. In similar way, the finished products going out of the factory should be loaded into the wagons or trucks directly from the packing house. In a factory where Ry. siding is available, the plan of the

factory should be so designed that all these facilities, can be obtained as far as possible from a single siding without having to rotate the wagons.

The plan of a factory should be worked out to make each unit in the operation independent of other units, so that in case of a breakdown in one unit, the other units do not suffer in production. In a pottery factory, the crushing operation should be independent of grinding and the latter unit independent of the making lines. There should be separate sections for casting, jolleying and pressing of wares. These shops for making the green wares should be situated as near the Kilns as possible, where the wares will be fired subsequently. The green or unfired clay wares are very fragile, so less movement for them would mean less chance of breakage and less cost in transit.

Periodic Kilns for firing pottery wares should be placed as closely together as possible consistent with the easy movement of the workers around them. It curtails the distance the wares must move to a minimum, shortens the flue length, and conserves the heat to some extent. In the case of tunnel kilns, the intake ends should be near the making lines and the exit ends towards the stores where sorting of the fired wares is made. The packing shed should be on the side of the stores.

In any case, the main facilities for transport of the necessary supplies will be the determining factor governing the general layout of the works with regard

to the site. The actual sequence of departments from receipt of materials to despatch of products is a matter of great importance. A strictly straight line treatment may not be as sound in practice as a horse-shoe arrangement where the railway siding may be placed across the poles of the horse-shoe, serving both stores and warehouse, with external traffic control brought together. The general office should be located near the main highway for the convenience of the visitors, but should also be not far from the various shops for easy access of the management.

The idea of the size of the building required is to be obtained by carefully listing the various processes, the several store rooms, offices, canteens etc. which go to make up the complete works. Then the question of the type of the building has to be decided upon.

Unless the site of the factory is in a congested area where the value of the land and other factors may make it necessary to build a multi-story building, it is always economical to build single story building for factory purpose. They have the advantage that it is possible to use roof lighting and take full advantage of natural light. There is also absence of vibration from heavy machineries and economy in space by the absence of stairwyas, lift space etc. It is also contended that supervision over the workers is much easier where they are all in one floor than when they are scattered over several floors.

The selection of the proper types of building and shed is to be made on the basis of economy, durability and on the suitability to the class of production. There are four types of materials for building :—wood, brick, concrete and steel frame. There are three types of roofs available :—the flat roof, the A-slanting roof and the saw-tooth slanting roof. The last mentioned roof will permit the full utilisation of sun-light inside the workshops.

In India, factory sheds with brick wall and tiled roofs have been found to be useful and economical. The tiles may be made of fired clay or of asbestos and cement. Corrugated iron sheets for roofing purpose are not so satisfactory for pottery works as they get heated up during hot summar days and in winter nights condensed water vapours drop from the ceillings and spoil the wares kept below. Flat roof is most common on concrete buildings but these roofs do not allow easy ventilation or the exit of hot and foul gases as is possible through the tiled roofs. Flat roofs are better suited for keeping the heat out and the top of the roof can be utillised for some useful purpose.

It is advisable to keep an air space of about an inch in all factory walls exposed outside ; this will ensure better temperature condition within the shops. A double ceilling of asbestos sheet or thin wooden planks will prevent heat from entering the shops from the roof during the hot summar days. Artificial sheets made

from sawdust, wood shavings, bagasse from sugar cane, and such fibrous waste materials as jute and cotton trimmings can be used for partition walls in factory buildings very satisfactorily, as these fibrous and porous boards are shock and vibration proof and insulating to heat and cold.

The general office of the factory should better be built with bricks and mortar as in many cases this building is made in more than one story for convenience of work and economy of space.

Where stone chips are easy to obtain and cement is cheap, modern concrete constructions for factory purpose may be economical in the long run and useful. Concrete buildings are clean and allow large windows for light and air. A building of this type however, is not so readily altered to be adapted for any other purpose than its original one, unlike brick and tiled sheds. In pottery works for making white wares, the floors of the shops where the green wares are made should be so constructed that they can be kept very clean so that the scrap body falling on the floors may be collected and used again without any risk of being mixed with dirt. The walls of the shops should also be made smooth by plastering so that dust may not collect on them.

In selecting plants and machineries for a new factory a complete knowledge of the shop practice and the capability of the various types of machines is essential so that discretion may be used in accepting or rejecting

a plant that is unsuitable in design or unduly costly. The costliest machine, however well designed, is not necessarily the right one for a particular purpose, while on the other hand, cheap machines can be dear at any price. The first step to be taken in the selection of new machines is to make a study of the product to be manufactured in the light of the quantity to be made, bearing in mind the type of labour available and the local market condition.

When the automatic tile press was first introduced in the market, it was difficult to find labour to work the press to its full capacity even in the European countries. The same difficulty may arise in India in working a modern automatic cup making machine if the local labour condition is not considered ahead. In ordering for any automatic plant or machinery the labour problem should be studied in advance.

The machineries bought for a particular section of the factory should be compatible with the machines of the other sections. For example, if in the production section of a pottery works, more clay mass is consumed than the grinding section can provide normally, some of the machines in the production line must be kept idle, or the grinding drums kept running for extra hours. In both cases there will be a loss for the business. The same consideration should be very carefully made between the capacity of Kilns and the production of green-wares.

The problem of power transmission for driving the machineries is not to be overlooked as this item involves a good part of the efficient driving of the machines and cost of upkeep and power loss. In the older system, the power from a central station was transmitted to the shops and machineries by shafting belts and gears and this involved great frictional losses on the way. A better system is the group drive, with one motor or oil engine driving a group of machineries in one department or shop. In this system the frictional loss due to long shafting and gearing is reduced but the best method is the individual drive, where each machine has its own electric motor which can be placed irrespective of any shafting arrangement. Although the first installation cost of this system is greater than any other method, the economy in running a motor only when it is needed is a big item in a large factory.

When shafting is essential, it should be supported on easy running ball-bearings placed at distances not more than 30 times the diameter of the shafting itself. The pulleys should be fixed to the shafting with keys as near the bearings as possible to avoid undue strain on the shafting. To prevent undue beltslip, the larger pulley should not be more than six times in diameter than the smaller one, otherwise the belt will not grip the lesser pulley sufficiently.

In selecting the connecting belting for the pulleys, consideration should be given to the choice of materials. Leather or camel hair beltings are common in this

country. Leather belts require constant attention, washing and oiling. Rope belting is used largely in English pottery works. They are very suitable when the distance between the two pulleys is very great or unusually short. The great pliability, strength and low rate of stretching make them specially suitable for drives round the corners and if they are kept dry they need very little attention.

To select the proper type of machinaries for the pottery manufacture, the principles of all the processes must be thoroughly understood. These are discussed in the following pages.

The problem of grinding the hard stony materials is the most important item in the ceramic industries, and the factory manager should be well versed with the principles of crushing and grinding so that he may select the proper machineries for his purpose.

The primary object of grinding solids to be subjected to chemical reaction is to subdivide the coarser particles to fine powder in order to expose larger surface of contact so that the reaction is completed in a minimum time. In making ceramic products where hard quartz and felspars are mixed with soft clays, homogeneous products will not be produced unless the harder substances are brought to the fineness of the softer clay particles. In this case, the finer the grinding the quicker will be the pyro-chemical reaction between the solid particles and better will be the final product.

The materials used in pottery manufacture are to be crushed and ground from big lumps to the fineness of about 200 mesh and in selecting machines for this purpose the following considerations should be made :—

1. Hardness of the material.
2. The size of the feed and discharge.
3. Total amount to be ground per day.

Natural minerals are divided by Moh according to their hardness in the following order :—

1. Talc.
2. Gypsum, graphite
3. Calcite, marble
4. Fluorite, magnesite
5. Apatite, chromite, hard lime stone
6. Orthoclase, felspars
7. Quartz, granite
8. Topaz
9. Corundum, emery
10. Diamond

For grindig hard materials below scale 4, low-speed grinding machines should be selected which will require low maintenace cost and the machines should be protected from dust to avoid excessive wearing out of the parts. The size and capacity of the machine will depend on actual reqirement. A large machine will require high initial cost and will entail large interest on money spent and depreciation value.

A single machine will not crush economically from a very large to a very fine particle size, hence the crushing and grinding of ceramic materials are divided into three stages :—

1. *Preliminary breaking.* In this stage, the big lumps are broken into smaller bits between $\frac{1}{4}$·—2 ins. size. For this purpose strong Jaw-crushers or gyratory crushers are used. These machines break the hard stones by continuous high pressure.

Jaw crushers are provided with two specially hardened corrugated steel plates one fixed and the other movable, known as the jaws, and the material is broken by squeezing between these jaws. The jaws are placed at an angle with the wider mouth upwards for the intake of the material. The distance between the two jaws at the discharge end can be adjusted by moving the fixed jaw forward or backward.

CAPACITES OF SOME JAW—CRUSHERS

(TONS PER HOUR)

Jaw opening Inches	Sizes of discharge				Power Consumtion H. P.
	$\frac{1}{4}''$	$\frac{3}{4}''$	1''	$1\frac{1}{2}''$	
5×6	0.3-0.4	0.4-0.6	0.5-0.7	0.8-1.0	3-4
6×12	0.8-1.0	1.2-2.0	1.5-2.5	0.2-3.0	15-20
6×16	1.0-1.5	1.5-2.5	2.0-3.0	2.5-3.5	20-30.
8×18	—	5.0-7.5	—	6.0-9.0	20-35.
12×24	—	8.0-12.0	—	15-17.	40-60.

The Jaw crusher was originally invented by E. N. Blake in 1858 and later on, several different types have been placed in the market. But Blake type of crusher is still largely used in ceramic industry. Blake crusher delivers a product uneven in size but this disadvantage does not affect the crushing of pottery materials as they are further crushed and pulverised in two more stages.

Gyratory crushers are generally used in crushing minerals and ores when an extremely large capacity can be utilised. The original installation cost and the maintenance cost of gyratory crushers are greater than those of Blake Jaw crushers but the comparative power consumption of the former is lower. To crush about 5 tons of rock to the size of about one inch a Jaw crusher requires 20-30 H. P. whereas a gyratory crusher needs only 6-8 H. P.

2. *Secondary crushing.* In this stage the broken pieces from the Jaw crusher are further subdivided so that the powder can pass easily through sieves of 10-20 mesh. At this stage it is essential to be careful of the fact that during this process of grinding, the raw materials should not get mixed up with any iron particles picked up from the grinding machine. For this reason only, many efficient secondary crushers are rejected for pottery purposes. The one which is largely used is the Pan-roller or Edge-runner mill.

This type of mill consists of two heavy rollers made of hard granite stone, fixed on the two ends of a

horizontal axis and made to rotate over a stone paved track provided on a round iron pan. This pan may be a fixed one, but in modern practice, it is also made to rotate slowly in the opposite direction of the rotation of the rollers. Since the outside of the rollers must travel a greater distance than the inside, there is a constant slip or shearing force, while the heavy weight of the rollers yield a crushing force. Hence a combination of two types of forces is utilised in this type of roller mills. A pair of brushes attached to the rollers automatically brush the powder over a sieve fixed at the inner side of the pan and bring back the coarser particles over the grinding path. This constant removal of the finer particles removes the cushion effect and increase the grindings efficiency.

When fire-clay or grog is to be ground, ordinary steel roller mills can be used. To get an idea of the grinding capacity of edge runner mills the following informations are given from a German catalogue :—

		No. 1	No, 2	No. 3
Diameter of the rollers in	m.m.	600	1000	1300
Width of the rollers in	m. m.	200	250	300
Rotation per minute	...	140	145	140
Power consumption	H. P.	1.5	6	8
Powder through 2 m. m. sieve per hour, in kilograms.				
(a) Fire clay ...	...	700	2000	3000
(b) Grog or felspar	...	400	1000	2000
(c) Quartz ...	...	200	550	1000

When powdering dry materials through this mill it is advisable to cover the mill to avoid dust trouble. Fine particles of silica whe floating in the air may cause silicosis disease in the workers. It is well known that quartz and flints expand on heating and become softer. So it is a general practice to calcine these materials at about 900°.C before grinding. Ceremic wares are often spotted on firing due to the presence of very small iron bearing particles in the clays or placing sand. It is not possible to remove these fine impurities from clays or sand by mere washing ; but they can be separated by powerful magnetic separators, either in the powdery state or in fluid form.

Messrs Eriez Mfg. Co. of U. S. A. have placed in the market their non-electric permanent magnetic separators in different forms like plates, pulleys, drums and pipeline traps, for separation of magnetic from non-magnetic materials. These magnets are made from Alnico alloy and work in all conditions of heat and moisture at their top efficiency. They are simple, powerful and permanently magnetized.

3. *Fine pulverising* —In this stage materials from $1\frac{1}{2}''$ inch size can be finely pulverised to any degree of finenel up to 200 mesh sieve. Hence it is obvious that stage No. 2 may be avoided, but in grinding pottery materials this is not desirable. Grinding in the second stage is accomplished with less power consumption than is possible in ordinary ballmills, because in the

latter case the cushion effect of the fine particles is not eliminated.

Ball mills or pebble drums, are largely used in pottery industry for their low cost, simple construction and ease of handling. These mills can be used for grinding both wet and dry to any degree of fineness. Wet grinding eliminates dust trouble, ensures better mixing of the materials in the subsequent stages and reduces power consumption. There are only two or three bearings in the whole machine and these can be enclosed in dust-proof journals. The mill is rotated at a low speed, so the wearing of the parts is also very low, which is a strong reason for there popularitly.

Ball mills for pottery purpose differ from ordinary mills as contamination of the ground product with iron should be avoided in grinding pottery materials. The steel balls of ordinary mills are replaced in this case with hard porcelain ones or selected flint pebbles. The inside surface of the iron drum is also lined with non-ferrous materials. This lining is an important factor. It is sometimes found that due to improper lining material, the latter wears out too soon with the result that the ground material gets contaminated with the powdered lining stone and it is not unlikely that even the iron of the drum may be exposed and wear out. The lining of the mill should be carefuly examined periodically and the lining replaced whenever necessary.

Most suitable lining used for pottery ball mills are silex and chert stones which are formed in nature by the deposition of silica, and are very hard materials. When suitable natural stones are not easily available, hard porcelain bricks or rubber blocks are also used for this purpose. Porcelain bricks should better be used for smaller drums and for grinding glazes and frits. For bigger drums, these bricks wear out rather too soon. These blocks and bricks should be so shaped that there is least space between the joints. The cement used for fixing these blocks should contain iron as low as possible.

In the case of ball mills, the grinding is effected by the combination of two different types of forces. One is the impact or blows of the balls falling from the top as the mill rotates slowly, and the other is the attrition or shearing force which rub the particles between the grinding pebbles.

The efficiency of ball mill depends on various factors, the important ones are discussed below :—

1. *Size of the mill*—The inside diameter of the grinding drum is an important factor to determine the size of the feed. As mentioned before, the grinding in a ball mill is done by the combined effects of pounding of the bigger balls or pebbles and the rubbing of the smaller ones against each other. The former force is greater when the balls are heavy and lifted up to a greater height. In pottery mills heavy steel balls can-

not be used. Hard porcelain balls or flint pebbles are only used in this case and the sp. gr. of these materials are rather low. Hence the only factor for increasing the pounding effect in this case is to increse the diameter of the drum. The actual feed size of the material will depend not only on the diameter of the drum but also on the hardness of the material to be ground. For example a mill with 5 ft. diameter will take felspar of about 2 inches size but quartz of smaller size. In smaller mills the feed must be pulverised to finer particles before it is fed to the mill.

2. *Speed of rotation of the mill*—This is a very important factor for efficient grinding in ball mills. When a mill rotates very slowly, the grinding pebbles simply slip along the side of the drum or roll round themselves. This rolling of pebbles helps in grinding the smaller particles only by the shearing force or attrition but does not help in pounding the bigger particles to smaller size. When the speed of rotation of the drum is increased slowly, the grinding pebbles are lifted up with the side of the drum till they lose their positions and drop down. The impact force of the balls will be maximum when they are lifted to the top and then drop down again ; but with the increase of the impact force the rolling of the pebbles will also decrease.

As the speed of the drum is increased further, the balls will fly clear across the drum and strike against the lining of the mill on the other side. At

this stage there will be greater wearing on the drum lining and less grinding of the material. At higher speed of the drum, the balls or pebbles are held against the side of the drum by centrifugal force and no grinding will be done.

Hence it is desirable to adjust the speed so as to get a combination of the impact and attrition forces to break the bigger particles to smaller size and then to pulverise the smaller ones into finer particles. In grinding wet, sufficient water should be added in the mill so that the ground material does not remain sticking to the pebbles and increase the cushion effect between the grinding pebbles. Generally 30-35 per cent of water is added and the material becomes so slippery that the actual grinding is mainly done by attrition. The speed of rotation of the mill for wet grinding is slower than that for dry grinding, generally by 30 per cent.

Opinions and practices vary as to the best speed to obtain the greatest efficiency. This has to be found out in every case. Some standard speed given below have been found to give good results in grinding felspar and quartz in pottery factories.

Internal Diameter	Revolution per minute	Internal Diameter	Revolution per minute
2′-0″	30-40	5′-0″	15-20
2′-6″	30-40	5′-6″	15-10
3′-0″	25-35	6′-0″	13-18
3′-6″	25-35	6′-6″	13-18
4′-0″	20-25	7′-0″	12-18
4′-6″	20-25	7′-6″	12-16

The lower values are for wet, and the higher values for dry grinding.

3. *Size and amount of grinding pebbles*—When a ball mill is charged with a particular size of balls or pebbles, the grinding proceeds to a certain limiting particle size beyond which further reduction of size of the particles is so slow as to be negligible for practical purposes. This limit to grinding by a definite size balls is known as the "free grinding limit." When the size of the pebbles is reduced, this free grinding limit will be extended to finer subdivision of the feed but the initial grinding of the coarser particles will be slowed down. In order to bring a compromise, an assortment of balls or pebbles is necessary for quicker grinding in ball mills. This assortment depends mainly on the nature and size of the feed and on the fineness of final product required.

Increasing the total weight of the grinding pebbles increases the fineness of the ground mass. This increase in weight may be effected either by adding more pebbles or balls up to a maximum capacity of about 50 per cent of the total volume of the mill or by using balls of heavier sp. gr. In pottery grinding, these grinding balls or pebbles are restricted to non-metallic materials only.

Generally hard porcelain balls, sp. gr. 2 3 or natural flint pebbles, sp. gr. 2.6 are used for this purpose. Sometimes quartz nodules, sp. gr. 2.65 are used for this purpose but they are not so satisfactory

as flint pebbles. When the amount of balls or pebbles are increased beyond certain limit there is a risk of their grinding themselves and the mill lining. In charging a ball mill it should be observed that the material to be ground should be sufficient so as to serve as a cushion between the grinding pebbles and when the mill rotates, there should be a dull rumbling sound and not sharp metallic one, indicating the absence of the pebbles striking each other on the drum lining.

The quantites and sizes of flint pebbles required for grinding felspar are given in the following table :—

Drum size	Charge of felspar	Total wt. of flint pebbles	Assortment of size		
			$1\frac{1}{2}$-2″	$2\frac{1}{2}$″	3″
Feet.	Lbs.	Lbs.	Lbs.	Lbs.	Lbs.
2×2	85	200	200	—	—
2×$2\frac{1}{2}$	125	250	200	50	—
2×3	175	300	200	100	—
3×4	560	1000	500	500	—
$3\frac{1}{2}$×4	800	1450	450	1000	—
$4\frac{1}{2}$×$4\frac{1}{2}$	1200	2200	—	2000	200
$4\frac{1}{2}$×5	1300	2500	—	2000	500
5×6	2300	4200	—	2200	2000
$5\frac{1}{2}$×$5\frac{1}{2}$	2300	2400	—	2200	2000
6×6	3400	6000	-	2000	4000

The pebbles and balls become reduced by use according to the hardness of the materials. This reduction roughly corresponds to 3 per cent per day of grinding and this loss must be replaced regularly for efficient grinding. The lining of the mill also wear

out in use. The life of a lining depends mainly on the hardness of the materials but also to a great extent on the proper charging of the mill and the speed of revolution of the drum. It has been found that the life of the lining is prolonged if the direction of revolution of the drum is reversed periodically, say every 3 to 4 months. It is also essential to examine the condition of the lining periodically.

4. *Duration of grinding* —The total period of grinding depends mainly on the factors discussed above. When all those factors are kept at normal, a larger cylinder will grind quicker than a smaller one. Wet grinding will grind to a finer state than dry grinding, which varies from 80 to 100 mesh while with wet grinding it can be taken up with 200 mesh. The minimum period for a particular fineness is first to be determined by practice and then the time required or the number of revolutions of the drum should be followed in every charge. A revolution meter fixed to the shaft of the drum is a better practice than recording the time of running of the drum.

A ball mill with about 2 tons capacity takes 35-36 hrs, while a smaller mill with about half ton capacity takes 40-42 hrs. for grinding up to 120 mesh ; the former mill takes charge of the size of nuts and the latter takes feed of 20-30 mesh from the edge runner mill.

Although the old and simple type of ball mills are still in extensive use in pottery factories, the present tendency is to replace them with tube mill or conical

mills, as these mills are continuous in action for a given output and thus much power is saved,

In general, a tube mill may be considered as an elongated ball mill where the length of the mill is much greater (about 4 times) than its diameter. These mills vary in size from 3-8 ft. in diameter and 10-30 ft. in length. The charge is fed at one end of the tube and it travels forward as it is being pulverised until the finest particles are discharged from the other end of the tube. The fineness of grinding in this case depends mainly on the rate of feed, other factors remaining the same as in the case of ordinary ball mills. The tube mill is important when a large quantity of material must be ground to different degree of fineness. For example, a 5×26 ft. mill will grind from 3 to 4 tons of felspar per hour to a fineness from 20-120 mesh.

In the case of conical ball mills of continuous type, the diameter of the mill at the feed and is larger than that at the exit end so that the total length of the mill is shorter than the tube mills. The conical shape of the mill causes a rapid classifying action within the drum both for the grinding of pebbles and the material to be ground. The coarser particles are being crushed by the greater impact of the larger pebbles or balls which always remain near the feed end, while the smaller particles are rubbed finer by the increased attrition force of the smaller pebbles till the pulverised mass is forced out automatically at the other end of the mill. This special classification economises

the power consumption and size of the mill over other types. Sizes vary from 2-10 ft. with grinding capacity from few pounds to 50 tons per hour.

Blunger. In purchasing machineries for the slip house different shop practices should be studied. If an extra roughing agitator is added, one is able practically to double the capacity of the blunging equipment. Generally it requires about one hour to get the clay slip from the blunger fit for fawning, but if an additional roughing agitator is attached, it does not require more than fifteen minutes to discharge the blunger into the roughing agitator where the final blunging will take place when a new mixing is put in the blunger. By this system there is always a supply of slip for the filter presses. The proper consistency of clay slip for the filter press is between 24-28 ozs. per pint.

The function of a blunger is three fold. It breaks the lumps of clay, mixes the ingredients thoroughly, and evacuates the entrapped air bubbles from the clay slip. These blungers or mixers consist of a large tank provided with one or two vertical shafts fitted with strong steel blades or beaters which break the clay lumps and create a whirlpool action mixing the materials thoroughly.

In the operation of a blunger, the tank is first filled with sufficient water, the machine is then started and the dry clay lumps shoved into the tank. When the lumps are thoroughly broken up, the ground slip of felspar and quartz are then poured in. It generally

takes 45 to 75 minutes to blunge one charge according to the nature of clay used. Porcelain bodies take less time than stone ware or earthen-ware bodies

The effect of evacuation of entrapped air bubbles on blunging a pottery slip can be judged from the following data :—

Time of blunging in minutes—

10	15	20	25	40	50

Change in sp. gr. of slip—

1.29	1.32	1.34	1.35	1.37	1.38

In some modern practice, the casting slip is made by connecting the blunger with a vacuum pump. The effect of this special evacuation is very marked in the first few minutes as will be observed from the following data :—

Time of evacuated blunging—

10	15	20	25	40	50

Change in. sp. gr. of slip—

1.35	1.36.	1.365	1.37	1.38	1.38

The capacity of these blungers vary according to the nature of clay slip to be made. For example a blunger which takes 6,500 lbs of dry body for making slip for the fitter press will take about 15,000 lbs of dry body for making casting slip.

Agitator—There is another type of liquid mixer used in the slip house of a pottery works, known as the Agitator. The work of this machine is to keep the clay slip constantly in motion so that the different

solid ingredients used in the slip do not settle down before the slip is pumped into the filter press. It is also used to keep the casting slip or the glaze slip homogeneous before they are used.

This agitator also consists of a large cylindrical tank either made of wood, or steel lined with vitrified bricks so that the slip do not come in contact with iron. The arms or wings for mixing are made of hard wood firmly bolted to a vertical shaft which is driven slowly by means of a driving gear. The speed of the mixing arms of the agitator is slower than that of a blunger so that fresh air may not get entrapped into the slip. This speed is generally from 10-15 revolutions per minute while the blunger blades rotate 40-45 times in a minute.

Slip pump. The blunger and the agitator of a slip house are generally constructed below the floor level where the ground materiels can easily flow from the ball mills. After blunging or mixing, the clay slip is raised to pass through the shifter or sieve and the electromagnet. This raising is done by means of special slip pumps.

As these pumps have to lift up and force out thick and heavy clay slip and their construction is made heavier than ordinary water pumps. The valves and valve chambers of these pumps get easily worn out by the abrasive actions of the particles of quartz and felspar present in the clay slip. These parts should have easy access to them so that they can be removed

and the worn out parts replaced. The pumping capacity of some slip pumps are given below :—

Suction pipe	Discharge Pipe	Diameter of Blunger	Stroke	Capacity gals.
$1\frac{1}{2}''$	$1\frac{1}{2}''$	4 ins.	6 ins.	18
2″	2″	4 ins.	11 ins.	30

Sieves. The clay slip after blunging is found to contain various foreign matters like fibers of jute, small chips of wood or leaves and coarser grits. In order to remove these materials the slip has to be sieved before it is sent te the electromagnet. The sieves or sifters used for this purpose in modern potteries are round or rectangular lawns made of phospher-bronze wire cloth. They are made to vibrate rapidly so that the thick clay slip easily and quickly passes through the fine wire cloth Generally two lawns are used one above the other, the upper one having a coarser cloth 80-100 mesh. while the lower one 100-120 mesh. The lawns are either made of wood or aluminium frame. The aluminium frames last a very long time and do not require replacing like wood frames.

The advantages of these trembling sifters are manifold. They require very small space and can be easily fitted up in any position. The work done by the small lawn is greatly increased by the vibration created by a small motor or about $\frac{1}{4}$ H P. The sieves can be easily inspected and cleaned when required. Another very useful advantage of these sifters is that

they may be used in conjunction with electromagent without intermediate pumping.

Electro-magnet. Natural clays used in pottery bodies often contain some iron compounds in the form of carbonate, sulphide and oxide. These materials are very weakly magnetic. The magnetic susceptibility of iron carbonate is 1.82 and that of iron sulphide 0.23 only, while that of iron is 100. Hence to remove these iron impurities from clay slip the particles must be in fine state and the magnetic field very strong. This is possible by powerful electromagnets only. It is not sufficient for the clay slip to flow in a stream over powerful magnets ; the slip must be in the form of a thin film, and the magnet faces must be innumerable and powerful to attract and retain the iron bearing particles flowing over them.

To deal with potters clay slip, several patented magnetising machines have been put in the market.

One simple type of magnetic separator consists of a bunch of several electromagnets which can be placed on the path of flow of the clay slip from the blunger to the storage ark. At regular intervals, the magnet is lifted up and the poles washed clean from the adhering impurities. These magnets work with direct current taking about 1-2 amperes.

Another type of a more popular apparatus made by Rapid Magnetting Machine Co. of Birmingham, consists of a trough which is built up of a series of powerful electromagnets, extending across the whole width

of the trough. Each magnet is provided with a number of projections which disturb the flow of the liquid and create numerous ripples like water running over a stony bed. These ripples cause constant frictional contact on the solid particles in the slip with the magnets and incidentally the iron bearing particles are arrested by the magnets.

An improved model of this apparatus know as Rapid Magnetic Percolator is fitted on the top of each magnetbar. This box-like frame, is detachable for cleaning, contains a number of pieces of perforated expanded metal ; a somewhat similar box frame is also fitted intermediately between each pair of magnets. The effect of this is to completely cover the bottom of the trough with a mass of magnetic edges, through which the clay slip must percolate. The capacity of these percolators will depend on the width of the trough and the efficiency on the length of the trough or number of magnets.

Width of the percolator inches.	No. of Magnet Units.	Current consumtion watts per hr.	Appox. capacity. Tons per hr.
24	10	1200	4-6
24	8	960	
24	6	720	
12	10	600	2-3
12	8	480	
12	6	360	
6	10	300	1-2
6	8	240	
6	6	180	

Another new type of magnetising apparatus used in the clay industry and known as Frantz Ferro-Filter, is placed in the market by S. G. Frantz Co. of New york. The gravity type Ferro-Filter which is most suitable for clay and glaze slips, consists essentially of a stack of grids, strongly magnetised by a direct current and placed inside an open bowl. The liquid is fed at the top of the bowl and flows through the grids which offer slight resistance to the flow, but present thousands of feet of magnetised edges to the materials passing through. These grids comb the liquid and the magnetic particles are retained on the edges until the end of the run. The Ferro-Filter fs then de-magnetised and flushed with water. The discharge opening is at the bottom of the bowl which is controlled by a float-valve giving an uniform low velocity to the liquid through the space occupied by the magnetised grids.

Model No.	31	41	51	61
Current at 115 Vt. in Amps.	1.0	1.2	2.0	2.5
Capcity U. S. Galls. per hr.	150	400	900	2000

Filter Press—This mechanical device is for dewatering the clay slip in order to make it into a plastic mass for further processing. A clay slip weighing 24 ozs. per pint, contains 67. 5 per cent of water while a plastic clay mass contains only 24-26 per cent water. This dewatering is actually effected by filling strong

canvas bags with the slip and then forcing out the excess water through the pores of the canvas cloth. The old Chinese process was to place the clay-silp filled bag between two wooden planks and then press the bag by weights placed on the wooden plank. From this age old method of de-watering the clay slip, the modern iron filter press has evolved.

A modern filter press for pottery works consists of a number of iron trays called leaves, grooved inside, in such a way that when two such trays or leaves are pressed together they form an enclosed space called a chamber. Several such chambers are supported on a strong iron frame to form a multi-chamber press. These chambers may be round or square in shape but through the centre of each leaf there is a hole running across the whole press through which clay slip is pumped inside the chambers of the press. A piece of strong canvas cloth slightly bigger than the size of the leaf is fixed on each side of a leaf by punching a hole at the centre of the cloth and tightening it up against the leaf with a brass ring. All the leaves or trays are then placed on the frame and then pressed against each other by means of a hand wheel or a ratchet so that in each compartment there is a canvas cloth bag to hold the clay slip.

The slip is pumped into the bags inside each chamber by means of a special clay-slip pump. When all the bags get filled up with slip, further force would begin to press the slip, when water in the slip would

pass out through the fine pores of the filter cloth leaving the clay mass inside the bags. After a short while, a layer of the clay mass will be deposited on each side of the bags which becomes the actual filtering medium. As this clayey layers become thicker and thicker the rate of filtering becomes slower and slower till the two layers on each side of a bag meet at the centre. This process takes from 45 minutes to an hour according to the nature of the clay mass. Open mass, like porcelain bodies, take less time, while fat masses, like stone ware bodies, containing very plastic clays take longer duration in filtering. This duration can be shortened by using a little flocculating electrolytes like common salt, dilute hydrochloric acid, or common alum.

The filter cloths require special attention on two important points. After some use the fine pores of the cloth get clogged up when they are easily ruptured by pressure if the pores are not opened up by washing. Further, the cloth gets rotten by the formation of mildew specially in hot and damp climates. In order to get rid of these troubles, filter press cloths should be periodically washed and cleaned. An emulsion of soft soap and creosote oil serves the dual purpose effectively. It cleanses the pores of the cloth and prevents the formation of mildew.

The capacity of a filter press depends mainly on the size and number of leaves in a press. These presses

generally work on 60 to 80 pounds pressure per square inch.

In the following table capacities of some filter press are given :—

Size of leaf. sq. ins	Capacity of each chamber.	Size of leaf sq. ins.	Capacity of each chamber.
9	3 lbs.	18	27 lbs.
12	9 "	24	45 "

Press pumps—Special force pumps are used for pumping the thick clay slip into the chambers of a filter press and pressing the water out of the slip through the canvas bags. The old diaphragm pumps are now replaced by modern constant pressure slip pumps, as in the latter case, the slip is forced into the press at the same rate as filtration takes place, so that the strain upon the cloths and the press is decreased ; and in consequence, the cost of maintenance is appreciably decreased.

The operation of this constant pressure pump is the same as that of a plunger pump with as little as possible of metal parts coming in contact with the slip. The plunger is weighted, which controls the amount of pressure the pump will deliver. When the desired pressure is reached, the pump will automatically stop work, maintaining this pressure, until the pressure in the bags drops, when the pump will begin to work again. It is possible with this kind of pumps to adjust any pressure between 50 to 100 lbs. simply by adding

or removing the weights on the plungers. This pressure is adjusted according to the nature of clay body used in pumping. There is no need of a safety valve in this type of pump hence less attention in working is needed.

Pugging – As the clayey body comes out of the filter press in the form of pressed cakes, the water content of the clay mass is not homogeneous throughout and some air bubbles are also entrapped in the cakes pressed from the slip pumps. The clay mass or body has to be made homogeneous both with its water content and entrapped air. This is done in a pug mill or kneading machine. Pug mills are generally used for heavy clay bodies like brick, tile, drain-pipe etc. or for saggar bodies, but for lean white mass, like porcelain bodies, kneading mills are preferred. The pugmills generally perform two functions simultaniously, while the kneading mills do only one. The pugmills first pug or knead the material into a suitable condition and then extrude it through a die to the desired form. The mass obtained from the kneading mill requires a separate extruding press.

It has often been said that a pug mill cannot do the two operations efficiently, and either the pugging is sacrificed for the extrusion or vice versa. In other words, if the machine is to be used for pugging only the knives could be better arranged to give greater efficiency, or if used for extrusion only, the rate of flow of

the mass and the quality of the extrusion could be improved upon.

Auger machines are now-a-days used in many countries for extrusion only. This type of machine has no part in the preparation of the material like the pug mill or the kneading mill. Therefore it should be borne in mind that the material should be thoroughly prepared before being fed into the auger machine. This machine has only a short barrel which is fitted with worms for the full length, for propelling the material. At the delivery end of the machine, a double bladed worm is fitted to impart even pressure to the mass of material to be forced through the die. The clay mass obtained from a auger machine is more tough and less open than from an ordinary pug mill, and there is also less tendency to lamination of the clay mass. Auger machines are more efficient and with properly prepared materials produce a better colour of pressed mass than the standard pug mills. They are capable of larger output and are not expensive from a power point of view.

In any type of extrusion machine there is a certain amount of air drawn into the clay by the knives. After a knife or worm has passed through a clay mass, the clay does not close up immediately due to its plasticity and inertia and the surrounding air which is much more fluid, is drawn into the voids caused by the passage of knife blades or worms. This layer of entrapped air causes laminated structure in the clay

mass which flows through the mouthpiece or die. By stream-lining the back edges of the knives instead of leaving them blunt, it is possible to eliminate the sucking action of the knives but the design of knives and worms should be adapted to the nature of clay-mass used to get the best result.

As it is not possible to experiment with every clay mass used in a factory, and change the design of the knives and worms to suit the purpose, the best way out is to extract the entrapped air from the extrusion machine before using the clay mass for moulding into wares. The method adopted is to use a pump to suck the air out from the clay. This method of de-airing of the clay mass has greatly improved the manufacture of hollow wares and sanitary pipes which often give trouble with blisters and lamination cracks caused by the entrapped air in the clay mass.

Since it is difficult to extract air from the middle of a large mass of clay, it has been found that by shredding the clay into small pieces, the best results are obtained. The de-airing machines are constructed in different forms by different manufacturers to suit the variety of requirements but the main principle of all these machineries is the same. In general, these machines consist of two units. The first unit consists of a barrel fitted with knives and worm, the end of which is closed by a perforated plate. When the clay is fed into this unit, it is forced by the worm through the perforations in the plate to form into thin pencils or

flakes. The size of the perforations in the plate varies with the nature of the clay worked. The shredded clay falls into a second barrel the upper portion of which is the vacuum chamber where suction is applied so that the air is drawn away when the clay is in loose formation before it enters the working barrel where it is compressed and forced into a die of required shape and size. To ensure that air cannot enter from outside, all joints are sealed.

The degree of vacuum created inside the chamber varies with different workers using different clays. Generally it varies from 25 to 28 inches of mercury column, the maximum vacuum practically attainable being 29 inches.

Opinions from practical workers vary widely on the water contents of the clay mass for de-airing treatment. On theoretical grounds, as pointed by T. W. Garve, (Bull. Amer. Cerm. Soc. 1936) it seems reasonable to expect a larger percentage of water than in ordinary case, to develop the full plasticity of a de-aired clay mass in which the whole of the surface of the grains are covered with water films only. In the case of a non-de-aired mass, a portion of the surface of the grains is occupied by absorbed air or other gasses which may replace an equal volume of water. This point has to be determined by actual practice.

Most of the de-aired clay goods would require somewhat longer drying schedule than similar wares made from the same mass without vacuum treatment. This is

mainly due to the fact that the de-aired clay mass is more compact and the rate of evaporation of water from a compact mass is slow. The drying loss is also low due to the greater strength of the de-aired clay product which reduces loss due to handling and transportation.

The firing schedule of de-aired clay wares is also extended. This increase of time would appear to be required almost entirely in the water-smoking and oxidation periods. The closer texture of de-aired clay would naturally tend to retard both the rate of removal of water and the oxdiation of carbon. Hence the increase of firing time is mainiy reported by those who use more carbonaceous clays.

To sum up the replies of his queries as reported by F. H. Clews, (Trans. Brit. Cerm. Soc. Vol. 37) one may say that :—

De-aired clay mixes cause heavier wear and tear on the knives and worms than the same mixes not de-aired, and these parts require to be kept in better condition for the de-airing process to gain the full advantages by this process.

Each type of clay requires somewhat different de-airing unit. The pitch of the feeder worm and the delivery worm and knives may require adjustment to suit the clay being worked.

More power consumption is needed for a de-airing plant than the corresponding ordinary pug mill. The amount may vary from 20 to 30 per cent more.

De-aired clay does not suit well for hand working. Two separate pieces of de-aired clay cannot readily be united together.

De-aired clay mass definitely improves the quality of the goods. The porosity and strength of the wares both before and after firing are improved. Some of the manufacturers report that the porosity was reduced from 6 to 2 per cent under the same firing. The firing temperature is also reduced to obtain the same amount of vitrification and the firing cracks decrease. In the cases of bricks and tiles, sharper edges are obtained.

Jolleying—All round articles, made from plastic clay-mass are either shaped by hand on a rotating disc known as potters' wheel or made by mechanical device called Jigger and Jolley. The mechanical device is more universally practiced now-a-days for its cheaper cost of production and easier manipulation. To work on a potters' wheel requires great experience and skill of the worker, but articles made on potters' wheel by experienced and skilled workers are of a better quality than those made on a jigger machine,

The jigger machine must be built very rigid and fitted with ball bearings on all rotating parts and the rotating spindle made of special alloy steel accurately ground to size. If the spindle is not accurate or wears out easily in use, the jigger head will shake or run eccentric. This condition of the machine is very harmful for the production, as it often leads to cracks

either in drying or in firing. These rotating jiggers generally require $\frac{1}{2}$ to $\frac{3}{4}$ H. P.

The jolley portion attached over the jigger-head should also be built rigidly and the pull down lever should not shake on operation. For making large jars, jugs etc. vertical jolley or monkey jolley was in general operation but the modern practice is to design double handled jolley or pull-down for this type of work. It being equipped with two handles with separate profiles, it is possible first to shape the bottom part of the piece and then make top part without the necessity of changing tools.

The profiles used for shaping the clay wares require special attention. Profiles are small iron tools which press the plastic clay mass against the plaster moulds and give the proper shape to the wares. The curves given in the profiles should be as gradual as possible without changing the shape of the wares materially. This precaution ensures the chances of cracking of the wares during drying. The profiles for making flat plates or dishes are curved in such a way that the wares do not touch each other when placed in the oven in pile for biscuit firing. If the wares touch at any point, they may stick together or crack during contraction in firing.

Profiles are generally made from mild steel sheets. The thickness of the sheet varies according to the thickness of the wares made and the nature of the clay-mass used. A sticky clay mass using fire clay or ball

clay requires a thicker profile than a lean mass for porcelain bodies. Similarly, profiles for making cups and saucers are thinner than those used for making thick insulators. In general, profiles used for lean porcelain bodies are from 3 to 5 mm. thick and for fat stoneware bodies are 5 to 10 mm. in thickness. Profiles used for making saggars are generally 10 mm. thick but they are further strengthened by a wooden pieces attached to them about 20-25 mm. in thickness. This precaution is taken so that the profile does not shake when it is pressed against the clay mass rotating in the mould over the jigger head. A shaky profile causes drying cracks in the wares.

The profiles must be kept accurately true ; and for this purpose a sketch book is kept in which the curved out lines of the profiles are preserved. When the edge of a profile gets worn out at some particular parts during working, it should be filed true again according to the preserved sketch. Every profile should be examined once a week for this purpose. Some Indian manufacturers prefer using wooden profiles on the plea that it is easier to make and cheaper in cost. But the more refiling cost of wooden profiles may counterbalance the original cost in the long run. Besides, wooden profiles when kept wet for a long time often get distorted in shape and create trouble.

In making a new profile, firstly a thick paper or cardboard is cut according to the curvature of the mould

used for making the ware. The selected piece of an iron sheet is then given the curvature of the card-board with a bevel of 45°. This bevel is necessary for cutting the clay off the mould. The rough profile is then placed on the mould and the curvature filed true to fit the mould correctly. When a profile is found satisfactoy after actual trials, its marking should be preserved in the sketch book with a number for future use. Sometimes it is found after experince that some alterations in the curvature of the profile are necessary to remove certain defects arising either in making or drying the wares ; the sketch of this altered curvature should be kept alongside the original in the sketch book, for comparison.

Pressing. Clay wares are pressed into shape either from the plastic mass or dry powder. The dry-press method is gradually gaining more popularity due to many advantages over the other methods. In this method less labour is required, shorter time for completing production, and no drying before the wares are sent to the kilns. Besides, the fired wares have less shrinkage and sharper edges.

In dry pressing, the clayey mass is first ground to powder and a small quantity of water is added in a mixer before pressing. The amount of water varies according to the nature of materials but is usually about 6 to 8 per cent. The grain size of the powdered material is very important, as, if ground too finely it does not bind well under pressure and also creates

difficulty in expelling the entrapped air. On the other hand, if the grains are too coarse the structure of the product will be too open and weak.

The method of applying pressure is also important. For dry pressing, pressure from both top and bottom of the die is essential to produce products of even density throughout. If pressure is only applied to the top, it is found that the product is weak and open at the bottom and vice versa. The pressure must also be applied slowly so that the entrapped air can escape easily.

The amount of pressure required for making different articles also vary greatly and for this reason different types of presses are needed.

For the pressing of small pieces such as radio bushings, textile guides, small wall cleats for electric wirings etc., half-throw lever press is used. It is very rapid in operation and requires one-half stroke of lever to press the desired article. The total pressure extended by this type of press does not usually exceed 500 lbs.

Hand Toggle presses are used for pressing electric porcelain switches, cut-outs and other pieces where a quick operating machine is desired and where different heights of dies are to be used. The usual total pressure of this type of presses is about 1000 lbs.

For pressing electrical porcelain plates, smaller refractory crucibles and other pieces that can be made simply by exerting pressure on one side only, single

compression screw presses are usually employed. The total pressure required is 20 to 25 tons.

For the pressing of dust pressed tiles or pieces that are heavy and thick, pressure from below as well as from the top is required to make them solid. For this purpose, double compression friction driven power presses are very suitable. For making wall and floor tiles the press should be fitted with an air-ejecting device, as it is far smoother and quicker in operation, few moving parts to wear out and gives longer life to the machine. These presses work at a total pressure of 75 to 100 tons.

In pressing complicated shapes with holes and screws, like electric switches, cut-outs etc., the clay powder should be mixed with a little oil. This mixture increases the plasticity of the powder and at the same time prevents sticking of the clay body to the dies. If vegetable oil is used for this purpose, it may saponify with the lime present in the clay and produce scums on the surface of the wares. These scums create trouble in subsequent glazing of the wares. Mineral oils also do not serve the purpose properly but a judicious mixture of a thick vegetable oil and a thin mineral oil gives the best results. A new product under the trade name 'Pheno-Oil' has been placed in the market by Messers Luna Chemical Industries Ltd., Benares, for mixing with clay powder for pressing. This product when mixed with sufficient water forms an emulsion which when mixed with the clay dust in very small

amount, produces sufficient plasticity for pressing all complicated shapes and prevents the wares from sticking to the dies.

Casting. This is the universal process by which all shapes of clay-wares can be produced with greater ease and less skilled labour. For successful casting of wares, the first essential is the preparation of the clay slip of proper consistency. It should not be very viscous or sticky and should flow easily to all corners of the mould but at the same time should not contain a large amount of water in it. This is adjusted with electrolytes of proper type and amount. All clays do not behave similarly with the same electrolyte, hence every new clay should be experimented upon and the proper electrolyte determined for making good casting slip.

If a casting slip contains more water than actually needed, it takes longer time to dry in the plaster mould; which means less number of turns a mould can be used per day and extra time and cost for drying the moulds. Plaster moulds become unserviceable if they are not dried regularly, and moulds are the costly item in the casting department of a clay works. When plaster moulds get rotten they can be utilised for other industrial purposes. Articles like crayon and pastel pencils, distempers etc. can be made very cheaply from this waste product.

Ordinarily, casting slips are made in such a consistency that they flow easily and have a sp. gr. 1.75, but with a little care, a good flowing slip can be made with

sp. gr. 1.8. This slight change in the sp. gr. means a reduction of water content from 31 to 28 per cent in the slip.

This reduction of water in the casting slip has a far reaching effect on the life of plaster moulds. These moulds, on constant use absorb some alkali salts from the slip. These salts react slowly with the plaster and produce soluble sodium sulphate. If the moulds are dried quickly, these soluble salts come out of the moulds and get deposited on their outer surface from where they can be cleaned, but when the moulds remain moist for a long period the sodium sulphate begins to crystalise slowly forming the well known Glaubers salt—$Na_2SO_4 10 H_2O$. During this process of slow crystalisation, a very great internal pressure is exerted within the moulds by the growing crystals and the solid mass disintegrates or lose its solidarity and crumble down easily under pressure.

During drying, the moulds should not be exposed for a long period to above 90° C as, otherwise the plaster will break down and lose its solidarity. A dryer working at 50-60° C is quite good for this purpose. This type of dryers can be installed easily and the waste heat from the kilns can be utilised for this purpose.

Drying. The drying of claywares is a very complicated process and proper attention is not given to this stage by our Indian manufacturers. Many defects in the manufactured articles coming out of the kilns can be

traced to faulty drying. Clays differ widely in their drying property and the drying peculiarity of the clay used must be studied carefully to achieve complete success in drying the wares.

The water present in a plastic clay body may be classified under the following groups :—

1. Chemically combined water. This water extends from 12-14 per cent of the natural clay mass and forms a part of the constitution of the clay. This water can be removed only at red heat and does not take any part in the drying stage.

2. Moisture. This water is absorbed by the clay from the atmospheric moisture and mostly retained by the colloidal substances present in the clay. It varies generally from 4-6 per cent of the weight of the clay depending on the season of the year and the amount of colloids present in the clay. This water can be removed only above 100° C, generally during the water smoking period of the kiln firing. Hence this water also does not take part in the drying stage.

3. Water of plasticity. This water is added in the clay to convert it into a plastic mass. In general, plastic clay bodies for making white wares, contain 22-24 per cent by weight of this water and casting slip bodies, contain 28-32 per cent of water. This added water has to be removed by the drying process and when the wares are *bone dry*, they are sent to the kiln where the water of the second and first groups are removed

gradually. A bone dry clayware generally contains 4-5 per cent of moisture.

Drying of clay wares takes place at all temperatures. As the water on the surface of the ware slowly evaporates it is replaced from inside the ware through numerous capillary passages in the clay body just like oil is supplied to the flame by the wick of a lamp. As water is removed from the pores of the clay particles, they come closer together and the clay ware shrinks ; if this shrinkage takes place uniformly on all sides the body will not crack in drying. But this ideal condition does not take place always due to various reasons. Clays are not alike in their chemical composition. The size and shape of the grains which make up the clay mass also differ from clay to clay. Some clays contain more colloids and soluble salts than others and these various factors greatly influence the capillary suction power of the wet clay mass when drying. The safety of drying the clay wares depends on the relative rate of surface evaporation and the replacement of water from inside. If this relation is not uniform, strain wlll be caused in the clay body due to un-equal shrinkage and the ware will crack.

Clays vary widely in their drying behaviour as well. Some clays may be dried slowly at the temperature of the atmosphere or quickly in a hot room or direct in the sun without cracking, while others require slow rise of temperature in a steam saturated atmosphere to avoid drying cracks. It is the second type of clays

that requires careful consideration and installation of artificial dryers.

It is important to bear in mind that drying cannot take place without the consumption of heat, and the same amount of heat is required in all cases for equal volume of water evaporated, whether the heat is supplied at low temperature or at higher temperature. Air takes part in drying only indirectly. It carries the heat to the hot wares and removes the water vapour generated from the wet wares. Air is not heated by radiation but gets heated up only in direct contact with the source of heat and then conveys the heat to the drying wares by convection currents which naturally move upwards or by mild wind.

When drying depends on direct radiation of heat from the hot floor or heated pipes, there should be as little movement of air between the hot source and the drying wares as possible, because the movement of air will only carry away the heat from both the hot source and the heated wares. In the other type of dryers the air is heated by contact with the hot source and then brought into contact with the drying wares. But in both the cases there should be a current of air to remove the water vapours generated from the drying wares maintaining the necessary vapour condition inside the dryer for safe drying of the wares.

In the pottery works, much heat is wasted either from the combustion gases of the kilns or from the exhaust steam from the boilers where there are boiler

installations. It may be noted here that from each pound of exhaust steam we can get 970 heat units and for each H. P. per hour 34·5 pounds of water is needed. Hence in a boiler installation of 100 H. P. working 10 hours per day, we can expect—34·5 x 970 x 100 x 10 or 33465000 heat units per day which can be utilised for drying the clay wares or for any other purpose.

The direct application of combustion gases in the dryers rapidly deteriorates the iron parts of the dryer and frequently causes scumming on the drying wares. Hence the use of waste gases from the kilns should be through a duct which serves to heat air for drying, in which we can get the benefit of the waste heat without the injurious effects of using the waste gases directly.

HEAT REQUIRED FOR DRYING.

In a white clay works of moderate size, 4-5 tons of mass is used per day. This mass will produce approximately any one of the following items :—

1.	Insulators of 6″ height	5,000 pieces
2.	Cups and saucers	12,000 pairs
3.	Miscellaneous articles like teapots, milk jugs, feeding cups etc.	10,000 pieces
4.	Sanitary wares—(a) Commodes	250 ,,
	(b) Wash basins	200 ,,
	(c) Indian Pans	550 ,,

These wares when worked from plastic mass will contain from 20-22 per cent of water which is to be

dried in the dryers before they are sent to the kiln. sn other words 2000 lbs. of water need be evaporated from the 10,000 lbs. of wares. Besides, there will be moulds containing the wares and iron and bricks on the cars in a modern tunnel. These materials also consume heat from the dryer.

To estimate the amount of heat units required for drying 5 tons of clay wares in a tunnel dryer, we have to take the following data into consideration :—

Total weight of clay wares	...	10,000 lbs.
Water content at 20 per cent	...	2,000 ,,
Iron parts in trucks	...	10,000 ,,
Brick work in trucks	...	5,000 ,,
Sp. ht. of clay and bricks	...	0·2
Sp. ht. of iron	...	0·12

Latent heat of vaporisation of water—536 Calories or 2123 B. T. U.

Temperature of atmosphere—70° F and that of the drying tunnel 120° F

HEAT CONSUMPTION IN DRYING

1. Amount of heat required for clay wares :—

   $10,000 \times 0.2 \times (120\text{-}70)$ 100,000 B. T. U.

2. Amount of heat required for water evaporation :—

   $(2000 \times 50) + (2123 \times 2000)$ 4,346,000 B. T. U.

3. Amount of heat required by the iron trucks :—

   $10,000 \times 0.12 \times 50$ 60,000 B. T. U.

4. Amount of heat required by the brick works :—

$5,000 \times 0.2 \times 50$	50,000 B. T. U.
Total heat	4,556,000 B. T. U.

HEAT AVAILABLE FROM WASTE GASES

The approximate amount of heat obtainable for drying from the firing of five tons of clay products can be derived from the following considerations :

Each ton of clay products requires 1.5 to 2.5 tons of coal depending on the temperture of firing. Taking an average of two tons of coal for each ton of wares, we require ten tons of coal ; and taking the average calorific value of Indian coal as 27300 B. T. U. or about 7000 calories, we get $2240 \times 10 \times 27300$ B T. U. from the fuel. Of this amount of heat, only 27 per cent passes with the flue gases of Ceramic kilns and hence the amount of heat avilable for drying is :—

$$\frac{2240 \times 10 \times 27300 \times 27}{100} \text{ or } 16,51,10,400 \text{ B.T.U.}$$

Thus we can see that about 36 times more heat is available from the flue gases of Ceramic kilns than is required for actual drying of the wares, but a large portion of this heat must flow out of the chimney to keep up a regular draught and a pull within the kiln for the gases to flow.

HEAT REQUIRED BY THE CHIMNEY

The amount of heat that must flow out of the chimney can be calculated as follows :—

Each ton of coal will require theoretically 9.2 tons of air for complete combustion, but generally 25 to 30 per cent more air must be supplied in actual practice. Thus we see that each ton of coal will produce about 12.5 tons of flue gases and as such, 10 tons of coal will yield 125 tons of flue gases. Taking the average temperature of the chimney gases at 300°F and the average sp. ht. of the flue gases as 0.25, we get the total heat flowing out of the chimney as follows :—

$125 \times 2240 \times 0.25 \times 300$ or 2,10 00,000 B. T. U.

From the above calculations we find, that near about one eighth of the heat flowing out of the Ceramic kilns is actually needed for keeping up the draught through the chimney ; but if the kilns are oil fired with a forced draught, this amount also is not necessary. Hence the waste heat available from the flue gases of Ceramic kilns are more than enough to dry the wares if utilised properly and the attention of all Indian pottery managers should be directed to this.

Some heat of course will be absorbed by the walls of the dryer, the flues and the chimney, and lost through them by radiation ; but if these walls are constructed by proper insulating bricks a good proportion of this radiation loss can be prevented. As the walls of dryer will not be heated above 150°F and those of

the chimney above 300°F, specially-made porous red clay bricks, will easily serve this purpose and they will be cheaper than fire clay bricks.

CHAPTER IV

FACTORY MANAGEMENT

Factory Records. In order to run a factory smoothly and economically, it is essential to keep records on each and every item and system. These records are documents that register the actual business of the factory, and not written specifically for any outside investigation. Records relating to the purchase of every material, power and fuel consumption and of the factory progress are absolutely necessary. Records of work from a team of workes or their individual output are intensely interesting to the men employed and profitable to the management. In Soviet Russia, the progress of the best workers, are periodically placed in the prominent notice of all other workers, not only of the same factory, but of other factories as well. This method serves as a stimulus to others and all try to do their utmost.

The main problem before the manager of a factory is to find out the method how to make three articles where only two are made now, and to solve this problem he must have the past records of the system of work not only in his own factory but from all other available sources. We have already given in Chapter I, some data of the production of pottery wares in factories in

various parts of India. These interesting figures very clearly indicate how individual Indian workers produce widely varying quantities of some type of articles either by hand or working on machines. This information will greatly help the manager of a pottery works to find out the means as how to increase his production and make it in the same level with the advanced workers of other countries.

By way of illustration, let us consider the benefits derived from keeping regular records in firing pottery kilns. It is important to know the fuel used in the firing kiln by kiln, in order to reduce the fuel consumption to its minimum. In this practice we shall find that some kilns consume more fuel than others and there must be a reason for it. After determining the cause for this difference we can remedy it either in the same kiln or build a new one correctly.

It has been found by investigation by Ohio State University Experimental Station that the consumption of fuel for making one million common bricks vary widely from a maximum of 1900 lbs. of coal to a minimum of 500 lbs. only. While this variation is due in some cases to the nature of clay used which is difficult to burn, in some cases to poor quality of fuel, or to faulty kiln design ; but in most cases the major part of the variation in the fuel consumption can be attributed to either the faulty type of kiln used, or to poor firing practice.

A difficult clay should not be selected as the basis of a business although it may be very cheap. Poor quality fuel may be profitable to use in some localities

but in majority of the cases it proves uneconomical in the long run. Selection of the wrong type of kiln, faulty kiln designs, or bad firing practice are factors, for which there can be no excuse.

In firing pottery kilns, a regular temperature chart should be kept and examined for each and every firing so that the firemen may not neglect their work, and uniform products are obtained in every firing. It is also very important to investigate and record the temperature difference in the different parts of the same kiln, so that if the variation is too great, steps may be taken to improve the firing condition.

A regular record of the output of kilns after every firing should be kept and examined so that we may come to know the nature and amount of defective wares obtained from individual kilns. Records of these defective wares indicate the plague spots in the whole system of manufacture and an intelligent worker will be able to remedy them.

The following figures from an English earthenware factory, making hollow wares, will clearly show how records from each kiln output can detect and check firing losses:—

BISCUIT OVEN RECORDS

Cracked	...	3.9	3.2	3.4
Crooked	...	2.5	4.9	4.4
Chipped	...	1.7	1.4	2.5
Specked	...	1.6	4.3	3.0
Flashed	...	0.2	0.1	—
Badly made	...	0.5	2.7	1.3
P. C. Loss	...	10.4	16.6	14.6

A glance into these records will easily point out the causes of greater loss in the firing from the same kiln.

Similar records from a German Porcelain factory give the following data :—

HIGH TENSION INSULATORS

Flawless	...	104	273
Spotted	...	2	8
Cracked		12	98
Broken	...	13	8
Total		131	387

The cause for the high rate of cracked wares in the second case can be investigated immediately from these records and prevented in the next firing.

LOW TENSION INSULATORS

Flawless	...	2400	3000
Spotted	...	65	30
Cracked	...	190	47
Broken	...	8	15
Total	...	2663	3092

These firing records not only indicate the different types of faults that may arise in the kiln, but also give an indication of the losses from different types of wares made in the factory which should be taken into account in calculating the cost of the article. An idea of this

kind can be obtained from the following data taken from the records of an English Earthen-ware factory :—

AVERAGE BISCUIT OVEN LOSSES OF DIFFERENT TYPES OF WARES

Cups	...	7 per cent
Saucers	...	13 " "
Basins	...	17 " "
Dishes	...	16 " "
Teapots	...	10 " "
5" Plates	...	10 " "
8" Plates	...	10 " "
Jugs	...	8 " "

The various statistics of a factory give their maximum usefulness for internal administration and commercial purposes, when they record the individual output of the workers, the departmental output, and the output of the work as a whole ; so that interchange of information and ideas can be had between members of the respective trade.

Records of individual output help directly for estimating production-cost, and rate fixing for a particular job. Periodical appreciation by the authorities, of performances of exceptional merit, gives encouragement not only to the individual worker but also to the whole band of workers and the standard of performance gradually improves. Some twenty years back, an Indian pottery worker could produce on a Jigger and Jolley machine some 300 to 400 pieces of tea cups only, but records of works from foreign factories with proper training of the workmen have improved

the performance of these workers to such an extent that some of them can produce about 1200 cups now and the average is about 900 pieces. If records of performances of individual workers are available easily, it becomes easier to fix the rate of a new job or estimate its cost of production in advance.

Departmental statistics furnish informations as to the total number of workers employed, and the absentees as noted day by day ; and all other information pertaining to the work of the department, such as, the power consumption, cost of supervision. inspection and maintenance of all plants, machine, tools, and implements etc., and the total output of the department as against the maximum expected output of the plant. These data enable the management to determine the percentage ratio of the "overhead charges" to the actual cost of production for any particular job. They also furnish valuable information for comparison of present with past achievements.

If a graph is plotted showing the ratio of actual production cost or *prime cost*, and the cost of managements etc., or the *on costs* every month or fortnight, a very tangible record will be obtained showing the efficiency of the department from time to time. The proper use of these statistics demands an intimate knowledge of how the figures are arrived at ; and the works manager should be responsible for the system by which the departmental data is collected.

The production statistics of the works as a whole may be derived by aggregation of the various departmental statistics in some cases, but ordinarily the total products as sold, is the record of progress of departmental efforts. Works statistics should cover all expenses directly pertaining to the manufacture, and also those which do not enter directly into the production, such as, shop-establishment, office charges etc. Those expenses which do not constitute the actual or prime cost of production, are termed as "On costs" in England and "Expense burden" in America. These costs are separable into two divisions :–

(1) Production on-cost. (2) Commercial on-cost.

Production on-costs include all expenses, besides the prime cost, up to and including the despatch of the product from the works. Expenses beyond this stage are conveniently considered as commercial on-costs. Unless statistics or actual data are kept regularly and honestly, it will not be possible to determine on what basis to charge the production and commercial on-costs over the prime cost of any article made in the factory. The method widely adopted is to apply the production and commercial on-costs, in those percentages which must be derived from actual works data. This simple method becomes rather risky so long the working of the factory is not standerdised and no abnormal condition arises during the period of work.

A detailed progress chart should be kept which shows at a glance the total amount of raw materials

received for each and every product, what proportion of the materials have been used and put into process, and the amounts still available. In the factory it is essential to know the whereabouts of any commodity at any time and this is possible by the use of progress charts.

From the progress chart many valuable condensed reports may be compiled as every incident of note is recorded from the begining of the progress to the finish of the product. The troubles experienced in any department are clearly set forth and the extra time if any taken by any section will be recorded. The works manager will know from this progress chart how much of his orders can be delivered to time and how much will be delayed to what extent.

Costing : The calculation of the costs of production on scientific basis is a subject which every manufacturer should follow rigidly. Without the knowledge of the actual cost of production, the manufacturer can not ascertain at what price he can sell his products with a profit, and where the weak spot of his organisation lies, so that he may take all necessary measures in time to remove the defects of his organisation. For example, it may be stated here that coal is cheaper in Bengal and Behar than in the Punjab or U.P., so that in India, a factory manager in any of the two latter provinces should be much more careful towards his fuel consumption than in the former two provinces.

A proper and regular system of cost keeping will greatly improve the position of the factory specially when there are other competitions both within and outside the country.

In calculating the cost of production in a factory, two different types of items are involved. In the first case, items of fluctuating nature are considered. These are:—cost of materials, labour and management charges etc. In the second case those items which involve expenses of a permanent nature are considered. These are :—depreciations on buildings and machines, interest on the capital outlay, insurance premium etc. All these items may be classified under the two following groups :—

A. *Factory cost.* Materials, labour, supervision, power consumptions, and rejections. These are "Prime costs" for production. Depreciations on buildings. sheds, furniture, machineries, tools and furnaces, repair of machines, tools etc., storage cost and delivery charges, works management and administration, insurance charges on buildings and machines, and interest on capital outlay, are extra costs or "On Costs."

B. *Office expenditures or commercial on-costs.* Office management, directors' remuneration, rent, repair and depreciation of the general office building and furniture ; stationery, stamps and telegram etc., bank charges, law and audit fees, commission on sale, travelling expenditure, advertisement.

The costs of labour and materials used in the manufacture are not very difficult to ascertain from actual expenditures, but the item on the depreciation of machines can be determined from past records only. In this case the data issued by U.S.A. Bureau of Standards on the lives and depreciations on ceramic tools and machineries, will be very helpful.

The average life of factory sheds where machineries are running daily is taken at 25 years and depreciation calculated at 4 per cent per annum. Furniture depreciation is calculated at $6\frac{1}{4}$ per cent

Storage charge for ceramic goods is generally calculated at 10 per cent on the cost of the article. This charge is due to the locking up of the money on the finished goods and the wages of the store keeper and his assistants, loss in breakage in store etc.

Name of Machines	Years of life	Depreciation
Crushers	15	$6\frac{2}{3}$ p. c.
Ball Mills	15	$6\frac{2}{3}$ p. c.
Blungers	12	$8\frac{1}{3}$ p. c.
Pug Mill	14	7 p, c.
Filter Press	15	$6\frac{2}{3}$ p. c.
Jiggers	10	10 p. c.
Clay Pumps	10	10 p. c.
Brick Machines	$12\frac{1}{2}$	8 p. c.
Tile Machine	17	6 p. c.
Sieves	8	$12\frac{1}{2}$ p. c.
Moulds	5	20 p. c.
Kilns	15	$6\frac{2}{3}$ p. c.

Packing charges are generally calculated at one per cent on the cost of the article but can go upto 5 per cent when the wares are very fragile and have to be sent to a greater distance. Care and inspection are necessary for good packing, for want of which the goods may be spoiled in transit.

Delivery charge is generally made at one per cent on the cost of the article ex-godown or within a limited area in the city.

Before attempting to find out the actual cost of making a particular ceramic article, let us compare the prices of raw materials in different countries.

COMPARATIVE PRICES OF CERAMIC MATERIALS
(PER TON)

Materials	Indian	English	German
Kaolin	Rs. 50/-	Rs. 90/-	Rs. 40/-
Fire clay	„ 20/-	„ 60/-	„ 18/-
Felspar powder	„ 60/-	„ 120/-	„ 50/-
Quartz powder	„ 60/-	„ 70/-	„ 40/-
Sand washed	„ 15/-	„ 50/-	„ 18/-
Gypsum	„ 30/-	„ 60/-	„ 25/-
Coal	„ 10/- 15/-	„ 30/-	Rs. 12/- Brikets
Ball clay		„ 75/-	
Cornish stone		„ 110/-	

The above rates are calculated on the exchange values of Rs. 15 per English pound, and As. -/12/- per German R. M. From the above, we find that India stands in an advantageous position over England as far as the raw materials for ceramic industry are concerned.

Cost data. 1. CALCULATION OF COST FOR MAKING ONE THOUSAND DOUBLE CUP INSULATORS OF J1 TYPE IN A GERMAN FACTORY

Each such insulator when dry weighs one K.G. Each support for insulators during firing and made from the same body composition weighs 0.15 kilo gram. Therefore the total amount of body-mass required for making one thousand insulators amounts to 1150 K. G.

Taking the average cost of body-mass at 63 R. M. per thousand K. G. we find,

The cost of body-mass ...	72.45 R. M.
Cost of making at R. M. 27 per thousand insulators ...	27.00 R. M.
Cost of glaze and dipping ...	2.35 R. M.
Cost of firing	140 R. M.
	241.8
Loss in firing 5 per cent ...	12.1
	253.9 R. M.
Over head charges, power and storage charges at 20 per cent	50.8
Packing & delivery charges at 5 p. c.	12.7
Office, & other charges at 30 p. c.	76.2
Total cost of making	393.6 R. M.

Taking the exchange value at As. -/12/- per R. M. we get the cost of making one thousand insulators of J_1 type Rs. 295.2 only in Germany.

2. Cost of making one thousand pairs of tea cups and saucers in an English earthen ware factory.

Each pair of cup and saucer weigh about 11 ozs. For thousand such pairs we require 11000 ozs. of body mass.

Taking the cost of English earthenware body at £ 6.25 per ton, we get

Cost of body mass ...	39.28	Shillings
Cost of making thousand pairs ...	38.00	,,
Cost of putting handles and cleaning	30.00	,,
Cost of biscuit firing	75.00	,,
	182.28	,,
Biscuit oven loss @ 10 per cent	18.22	,,
	200.5	,,
Cost of glazing	5.5	,,
Cost of glost firing ...	85.0	,,
	291.0	,,
Glost oven loss at 15 per cent	43.6	,,
	334.6	,,
Overhead, storage, power etc. @ 20 per cent ...	66.92	,,
Office & other charges at 30 p. c.	90.38	,,
Packing and delivery charge at 5 per cent	16.73	,,
Total cost of making	501.63	,,

Thus we find the cost of making one thousand pairs of English earthenware cups and saucers comes up to Rs. 381/7/-.

3. COST OF MAKING ONE THOUSAND PAIRS OF CUPS AND SAUCER OF SEMI PORCELAIN TYPE IN AN INDIAN FACTORY.

Taking the cost of porcelain body mass in India at Rs. 55/- per ton, and weight of one thousand pairs of cups and saucers at 11000 ozs. we get :—

	Rs.	As.
Cost of body mass	16	14
Cost of making As. -/4/- per 100 pairs	2	8
Cost of putting handle and cleaning ...	2	0
Cost of biscuit firing	20	0
	41	6
Biscuit firing loss at 15 p. c. ...	6	4
Cost of glazing	2	6
Cost of glost firing	30	0
	80	0
Glost oven loss at 20 p. c.	16	0
	96	0
Overhead charge, storage etc. at 20 p. c.	19	4
Office and other charges at 30 p. c.	28	12
Packing and delivery at 5 p. c.	4	12
Total cost	148	12

4. COST OF MAKING ONE HUNDRED SANITARY WARES :—(a) COMMODES. (b) INDIAN PANS. (c) WASH BASINS.

The average weights of these wares are :—

(a) Commode	...	40 lbs. each
(b) Indian Pans	...	20 „ „
(c) Wash basins	...	55 „ „

Therefore the cost of body for 100 pieces taking Rs. 50 per ton of body and five per cent loss in making,

(a) Commode	...	Rs. 105
(b) Indian Pans	...	Rs. 52.5
(c) Wash basins	...	Rs. 144.5

Cost of making and finishing and glazing.

(a) Commodes.

Making charge at Rs. 7/8/- each.	Rs. 750
Finishing at Rs. 2/- each ...	,, 200
Glazing cost at Rs. 1/4/- each	,, 125
	Rs. 1075

(b) Indian pan.

Making charge at Rs. 4 each ...	Rs. 400
Finishing charge at Re. 1 each	,, 100
Glazing cost at As. 12 each	,, 75
	Rs. 575

(c) Wash basins.

Making charge at Rs. 10/- each	Rs. 1000
Finishing charge at Rs. 2/8/- each.	,, 250
Glazing cost at Rs. 1/8/- each	,, 150
	Rs. 14,00

Average firing cost for 100 pieces, including 20 per cent loss in firing are as follows :—

(a) Commodes	...	Rs. 750
(b) Indian pans	...	,, 350
(c) Wash basins	...	,, 1100

Hence the total cost of making each article comes up to :—

(a) Comode Rs. 19.3 (b) Indian pan. Rs. 9.77. (c) Wash basin Rs. 26.44.

Class products : During the firing of pottery wares different types of articles are grouped together and placed in the same position in the kilns so that they may be fired under the same condition. These articles are known as the class-products. The following data from an English earthenware factory will be helpful to know the nature of these articles.

First Ring—This ring is next to the bags through which the hot gases and flames enter into the chamber and naturally gets the largest amount of heat. Cups, saucers, high jugs and similar articles of light weight which need hard firing are placed in this ring.

Second Ring : Oval dishes, soup plates, feeding cups, milk jugs, teapots are placed in this ring.

Third Ring : Plates of half or quarter size are placed in this ring.

Fourth Ring : In this ring large hollowwares like ewers, basins etc are placed together.

Fifth Ring : Large plates and dishes of full size are placed here so that they are not deformed by high temperature of firing.

These class products are made by different processes and in different sections of the factory, and it is essential to supply these articles in time and in sufficient quantities to the firing section so that the foreman for firing is not detained in his job or the Kiln is not fired without being fully loaded. The cost of firing is the largest item in a pottery factory and any kiln space not utilised means money burnt away. A strict

co-ordination is needed between the different sections of the making lines and the foreman in charge of making should see that no particular product is unduly progressed while the production of other types is slow. In the first case the green wares will have to wait for the next kiln and dust will accumulate on them, and in the second case the kiln will have to wait for full loading. This means loss of time and wages. Execution of orders in proper time is an essential part of business which the manager of the factory should always bear in mind.

Waste products : In a large pottery factory there are various types of waste products which can be utilised with profit. The droppings from the making lines often get contaminated with dirts of the floor and it is not advisable to mix these droppings with the main body as this practice often produces spotted wares. These droppings are better utilised for pressing into wall clits, ceiling rose, switches etc. Another useful purpose in which these droppings can be utilised is, for making mottled wares with red or buff burning clays with a transparent glaze. These wares are very attractive and are good sellers.

The fired pitchers or broken wares are best utilised by pulverising them again and mixing with fresh bodies or glazes. The biscuit pitchers are used with the bodies to the extent of 10-15 per cent while the glost pitchers are mixed with the glaze up to 20 per cent.

Waste mould from a pottery works is a valuable item which can be utilised with profit. The moulds can be reconditioned into plaster and used with fresh plaster for making new moulds and this practice will save a considerable amount of money in a large pottery works. (vide, "Utilisation of waste moulds" by Ranjit Singh and Bose. Jr Indian Ceramic Soc. 1947.) The waste moulds can be utilised for other products like distemper, cravons, pastels etc.

The cinders obtained from the kilns of a large pottery works are quite considerable in amount and they can be used in making mortars for buildings either with lime or cement. Cinder lime mortars are quite strong and durable. As the cinders do not contain easily soluble salts, the mortars made from them do not form scums or efflorescence after use like ordinary sand-lime mortars. Another useful article of building construction can be made from these cinders. The so-called "sand-lime" bricks can be made by replacing the sand by cinder with advantage and economy. The process is described in the book "Modern Pottery Manufacture" by this author.

Labour management. The foundation of industrial prosperity is production ; and a factory makes its name out of quality products. Uniform production of high grade wares makes for stable and enduring business and creates a commercial goodwill which is an essential part of the foundation on which to build a permanent business. The more profit is not the final or the most

important consideration in industry. A sound enduring business built up by willing, intelligent and contented workers is of far more importance and far more profitable in the long run both for the industry and the country.

The three essential parts of a factory are :-Capital, Management and Labour. Capital is necessary to a business for the purchase of plants, raw materials and to meet the working expenses. Management is concerned with the disbursement of the capital for the purchase and erection of the plants and machineries, the control of labour for production, and the general organisation of the business. Labour undertakes the conversion of the raw materials into the finished products aided by the plants and machineries. For success and smooth working, there should be co-ordination, co-operation and understanding between these three parties.

The chief obstacles to co-operation between labour and management is the question of status. The development of modern industries has turned the operatives into mere parts or cogs in the industrial machineries The average working man has no hand or say in the management of the business, so he has no interest in the success of business except that it should not collapse altogether.

The same difficulty arises in the case of distribution of earnings. The worker feels that his labour is treated as a mere commodity, the market value of which may

be forced down by the employers, irrespective of any consideration of a decent standard of living or even mere subsistance, as happens in this country. He is apt to think that he receives the fruit of his toil not as a matter of right or as the equitable division of the proceeds of a joint effort, but as a dole fixed by the arbitrary will of the employers, who may put him out of employment which is the main source of earning his livelihood.

The effect of this trend of mind is the tendency on the part of the workers to reduce his work to a mechanical routine without having any real interest or joy in his job. The workers further believe that if each man were allowed to produce to his full power, the minimum standard of work demanded by the employer would be based on the performance of the most skillful and quickest amongst them, involving either excessive strain or lessened earnings for the average workers. From this point of view the ablest workers try to restrict their output as a sacrifice on their part and as a safeguard for the majority. This tendency for the restriction of output does not allow to improve the production efficiency.

The fundamental grievance of the present day workers is that the actual conditions of industry have given to the employers full control not only over the mechanisms of production but also over the labour itself. They feel that the concentration of capital in a comparatively few hands, has rendered fair bargaining

between capital and labour impossible. The attitude of a certain section of employers who look on their employees as part and parcel of the industrial wheel having no recognised right as human beings, is bitterly resented by the workers, and still more offensive is the attitude which requires the working man only to be guided and disciplined, but not to be consulted in matters vitally affecting his interest.

The underlying principle of management should be full co-operation between the employer and employee and square dealing with them. A factory can no more be governed by discipline alone and succeed, than can a nation. Discipline must be sweetened by a friendly courtesy and understanding. Discipline without self sufficiency, courtesy without condescension, affability without familiarity will not make men feel at home and will not prove most potent to win the mind of the workers which is the greatest factor for a firm's success.

The direct link between the workers and the management are the foremen. A foreman is appointed over a group of workers to convey the necessary instructions to all the workers and to get these instructions carried out. There are foremen of such natural administrative ability that they are able to carry out their duties with some regard to the individual workers, but in many cases they are ill chosen for the work and yet their deficiency is not apparent to the management. The foreman of a pottery works should have enough

patience to examine the work of every individual worker under his charge, as defects arising in the course of manufacture of clay wares often disappear like a meandering river but only to reappear after firing, when there is no means to cure the defective wares. The man who does not realise this responsibility but is satisfied with the general supervision of his team only, is not to be trusted within a pottery factory although he may be a honest and hardworking person.

The responsibility of a foreman is multifarious. He is responsible for the proper selection of workers, their punctuality in attendance and economical production of the wares He looks after the training of learners and supplies each worker with his job so tha no worker or any machine remains idle, providing for the absentees and maintaining the plants in efficient condition.

All these multifarious works and responsibility are likely to cause strain in the mind of the foreman and he is liable to get ill tempered which may rouse ill feeling and discontent amongst the workers. A foreman should guide his workers as a captain with his team, exacting an winning the maximum loyalty and support.

Emphasis may be laid here on the great benefit that can be derived from the practice of the works manager meeting the foremen regularly in a committee to discuss the inter-departmental working. The point to be borne in mind is, that the foremen represent the management in dealing with the workmen and if the foremen become

dissatisfied, the disturbing influence consciously or unconsciously exerted on the workmen may prove disastrous.

Selection of workers and allotment of works to them are important factors for the management. Workers engaged without reference to their suitability for the particular type of work for which they are selected, generally become dissatisfied and their work becomes unsatisfactory. A bad initial selection of workers leads to inefficient management and the factory becomes unpopular due to high labour dismissals.

Factory work in general, can be divided into two broad groups,—Muscular, and dexterous. For those odd jobs where only physical strength is the main factor, such as carrying materials to the machineries, or carrying away the products, men with good physique should be selected. For those works where some skill and dexterity are essential, men with some intelligence should be preferred. These men, if they are not skilled in the particular job for which they are selected, can be trained up easily for the purpose. Arrangements should be made in every factory for training new workers or young recruits, either by some skilled workmen or the foremen. The system of delivering a few lectures on the principle and method of working, supplimenting the actual practice, has been found to be very helpful to train up workers quickly.

The method of payment of wages to the workers exerts some effects on their mind. The oldest and the

simplest method of wage payment is the Day Work system. The essence of this system is that the worker is paid on the time basis and not on the basis of work done. An absentee from work forfeits his wages for the period of his absence. In this system, it is assumed that all workers work honestly, and they are all treated alike irrespective of individual efficiency or defects. It is therefore clear that this method of wage payment admits of a great range of both quantity and quality of work done by workers of various types.

The Day Work system of wage payment is most suitable for muscular or manual workers when a variety of work has to be performed, and also to the staff employees both in the office and for supervision on salary basis. This system secures a greater measure of accuracy and careful work than other systems, as the workers do not gain anything in hurrying up their work. It also does not need close inspection of the foreman.

In order to promote interest in the workers specially to increase production, the Piece Work system has been introduced. In this system the wages earned by the workers depend on the amount of work done by them and not on the time spent on the work, as in previous case, so that the quicker workers earn more han those who work slowly.

Amongst a large section of organised labour, there is definite opposition to the Piece Work system of wage payment, and their hostility is not without a cause.

Often it has been found that the employers have cut down Piece Work prices, when through sheer industry, workers have earned high wages. In some cases, it is not uncommon that irregular or inadequate supply of materials, and stoppage or breakdown of machineries have adverse effect on the speed of production which brings down the wages of the workers.

The Piece Work system on the other hand, necessitates adequate provision for inspection, otherwise there is danger of defective work resulting from the workers, merely in order to increase the number of products. This tendency is specially dangerous in pottery industry where most of the making defects are not apparent in the wares until they are fired. On firing, the defects appear when it is too late for any remedy. If Piece Work system is to be followed in a pottery works, it will not be unwise to fix the rates on the basis of fired wares rather than on green articles. In any case the counting should be done when the wares are in the perfectly dry condition.

Whatever may be the method of payment adopted by the employer, the management should see that the workers are not overlooked or strained in body and mind, during their stay within the factoy. Monotonous application for long hours at relatively light work induces an incapacity for work or fatigue as serious as employment for short hours at more strenuous work. This incapacity is more prominent when the lighter work is mainly of a mental character, such as watching

and controlling a small machinery that does the same job continuously, and when the heavier work is mainly of mechanical character like lifting heavy loads throughout the day.

The overstrained person is naturally irritable and prove to be unduly sensitive. He hugs his fancied or exaggerated grievances and loses his perspective of the relations between himself and others. Such a person is difficult to control within the discipline of the factory.

In order to minimise the fatigue in workers the hours of work and the periods of rest must be regulated in different industries according to the nature of occupation involved. The monotony of work can be reduced by creating the worker's interest in his job, or by periodical changes in his work, each worker being trained in some other work besides his regular job. Employees for monotonous job should be specially selected from those workers who have no great desire for variety of occupation.

CHAPTER V.

FACTORY SCHEMES.

Schemes for a factory should be drawn by one who has full knowledge and experience of all the processes involved in the manufacture and has gathered all the necessary informations regarding the local conditions such as, the availability of all materials, suitability of labour, condition and means of transport, and market facility. It is a tendency of capitalists specially in India, that if they see one factory doing good business in any special commodity, they would try to launch more factories in the same line without carefully scrutinising the market ; and the inevitable result is unfair competition due to overproduction. In some cases it has been found that factories have been started without considering the factors of materials or labour facility. These factories are sure to come to grief sooner or later either for want of materials, or due to heavy labour cost from imported labourers. Both these factors are important for consideration in a new factory.

In countries like America and England where labour is very dear, modern labour saving devices are freely used, but in India where labour is comparatively cheaper, these costly devices can be avoided subject to economy of production. When a new scheme for a

pottery factory is made, the selection of machineries should be based on the condition and nature of labour available in the locality and the amount of production to be made, as otherwise some costly machines may remain idle partly or wholly for want of suitable operators.

The machineries provided should have excess capacity, either by heavier feed or speeding up, to provide for contingencies, but the actual operation should be in balance with the capacity of the driers and kilns. The kilns are the most expensive part of a clay plant. Therefore one should not build any more kilns than are absolutely needed for economic and efficient working of the plant, and other machineries should be balanced with the kiln capacity. It is better to keep a machine idle partly or wholly for some time, than to keep a costly kiln idle.

Different conditions are met with in different types of kilns like—up draught, down draught, continuous, and car tunnel kilns. A car-tunnel kiln must be supplied with wares continuously even during nights and holidays, when the factory is not able to produce. Such requirements must be met by proper storage provisions, and a factory using this type of kilns must adjust its machineries and store spaces according to the requirements of the kilns.

It is not wise to produce several types of ceramic wares from the same factory, which need different treatments in their production, not only in firing but in the previous stages of manufacture too.

Projects of this mixed type can not expand either in quality or quantity production. So it is prudent to consider the type of products to be manufactured out of the same works with respect to the market conditions.

In the following pages some directions have been given for drawing up schemes for making different types of wares, but these directions are not claimed as final or ideal. Scheme for a clay works embodies manifold problems covering the fields of civil, mechanical, electrical, and chemical engineering as well as the knowledge of mining and fuels.

1. SCHEME OF A FIRE-BRICK WORKS CAPABLE OF MAKING 10,000 BRICKS PER DAY,

Taking four tons of dry mass for one thousand bricks, we require 40 tons of mass per day.

Procedure: The big lumps of fire clay are broken into small pieces and all iron bearing nodules are sorted out. For this reason, breaking of the lumps by manual labour is preferred to heavy machineries.

After breaking and sorting, the fire clay should be well dried, as moist clays do not powder finely. The next step is to powder the clay finely in an edge-runner mill, preferably with a rotating pan driven from top. Mills with rotating pans give better results than those with fixed pan. The pan should have a perforated sieve with 2 mm or 1/10 inch slits. A similar mill for grin-

ding the *grog* should have rotating pan with a sieve having 3 mm or 1/8 inch slits. For proper control of the grog size, the powdered grog should be sieved and graded before use.

The powdered clay and grog in their proper proportions are then charged into soaking pits where adjusted quantity of water is added and the mass left for 24 hours for thorough soaking. There should be two sets of pits for this purpose so that when one set of mass is left for soaking the other should be ready for working. For each ton of mass about 2 cu. yds of pit space are needed so that for a factory dealing with 40 tons of mass daily, there should be two sets of pits with a capacity of 80 cu. yds in each set.

The mixture of clay and grog thoroughly soaked with water is now fed into a horizontal mixer for thorough mixing of clay and grog. This mixer consists of a long trough provided with two parallel shafts containing strong blades which cut and mix the mass as the two shafts are made to rotate slowly. Proper mixing is very essential to get a homogeneous mass which will not give any trouble when the bricks made of it are dried or fired. The mechanical mixers should be placed in such a position that the mixed mass from them fall automatically into the pug mills so that no manual labour is needed for the purpose.

The function of the pug-mill is to compress the mass into a compact body ready for moulding into bricks.

Moulding of bricks is done in India by hand pressing. An experienced brick layer can make 800—1000 fire bricks per day assisted by a boy. These bricks after they are semi-dried, are re-pressed in an iron mould to give accurate shape. The hand laying of bricks in the first stage is replaced in some cases by wire cutting system as the clay mass is pressed out from the pug mill. One man can handle 100—120 pressed bricks per wheel barrow.

Machineries:

1. One pan-roller mill with rotating base and provided with a sieve having 2 mm. or 1/10 inch slits suitable for grinding fire clays. Capacity 3—4 tons per hour. Power 9—10 H.P.

2. One similar mill provided with a sieve of 3 mm. 1/8 inch slits, suitable for grinding grog. Capacity 3-4 tons. Power 9—10 H P.

3. One 20 H.P. slow speed motor for driving the above, two machines, with shaft pulleys etc.

4. 5. Two horizontal trough mixers with double shafts for mixing clay and grog with water. Capacity 2 — 3 tons per hour each. H P. 4 — 5 each.

6. 7. Two horizontal pug mills or Auger mills fitted with wire cutting table. Capacity for each 3 tons per hour. H. P. required for each 10.

8. One 30 H. P. slow speed motor for driving the above four machines, with shafts, pulleys etc.

9. Fourteen hand presses with iron moulds, tools etc. for re-pressing the bricks.

Besides the above mentioned machines, some more accessories like wooden planks, drying shelves, wooden moulds, cutting tools, wheel barrows etc. will be needed.

Furnaces :

One cubic yard is covered by 384 bricks. Therefore, a daily production of 10,000 bricks will require 26 cubic yards. Taking 25 working days in a month, one has to provide for 650 cubic yards of space. The bricks are laid in the kiln on their edges 5/8 inch apart, so that for each three sets of bricks, 5/4 inch space should be kept vacant for the circulation of furnace gases.

This space comes to about 14 per cent of the area occupied by the bricks. Allowing 6 per cent more space below the crown and near the bags, we find that 20 per cent more space should be provided in the kiln for properly setting and firing the bricks. This comes to aboute 780 cubic yards of kiln space.

In the case of fire bricks we can expect to get two firings per month. Hence kiln space of 390 cubic yards must be provided for. If the kilns are made 4 yards high, the floor area comes to 97.5 sq. yards, which may be divided into two kilns of 23.4 ft. diameter or into three kilns of 19.2 ft. diameter. One man can set in kilns in gang 8000-10000 bricks per day.

2. SCHEME OF A STONE WARE FACTORY WITH A CAPACITY OF FIVE TONS OF BODY PER DAY.

In this factory the following articles will be made : Jars and carboys for household purposes and for holding acids for chemical works ; and other sundry articles with salt glaze.

The factory will have the following main departments :—

1. Slip house ; for making the body.
2. Making line ; for shaping the wares.
3. Plaster house ; for making plaster and moulds.
4. Kiln house ; for firing the wares.
5. General department.

Slip house : In this department the felsper and quartz will be finely ground, then mixed with previously pulverised fire clay and thoroughly blunged together. Suitable electrolytes can be added in the blunger to make casting slip.

MACHINERIES & ACCESSORIES REQUIRED

1. One jaw crusher for crushing the lumps of felspar and quartz to small pieces of about $\frac{1}{2}$ inch size. Capacity 1-2 tons per hour ; Power required 10 H. P.

2-4. Three large ball mills having grinding capacity of one ton material each. Power 5-6 H. P. each.

5. One strong screw blunger. Size 6″X5″. Power 4 H. P.

6. One vibrating sieve 18″ diameter fitted with a half H. P. motor.

7. One storage tank for slip, fitted with a wooden agitator. Power 3-4 H. P.

8. One pan roller mill for grinding fire clay and grog with rotating base provided with a sieve of 1/10th inch or 2 mm slites. H. P. required 2-3.

9. One slow speed motor for the above machines H. P. 30.

NOTE.—The first mechine Jaw crusher may be avoided and the last machine pan roller mill can be utilised for both the purposes.

If plastic moulding is necessary, a set of filter press with a slip pump and a pug mill will be required.

Making line. The jars and carboys will be made mainly by casting. The smaller articles may be made on potter's wheels or by jolleying.

Taking the average green weight of 5-6 lbs, for each article, about 2 thousand articles will be made per day from 5 tons of body. In casting thick articles from stone ware body, one can expect 2-3 castings per day from each mould. Hence about one thousand plaster moulds will be needed in the moulding department for casting only. Beside, there should be casting benches, drying racks, wooden planks, trimming tools etc. After casting, the articles are dried either on open racks or inside heated driers and then they are trimmed and finished by separate band of workers. They are then sent for firing.

Plaster house. In this section gypsum will be crushed, pulverised and sieved for making plaster. The gypsum powder is calcined in iron kettle or pan and then made into suitable moulds for casting.

MACHINERIES AND ACCESSORIES.

1. One edge runner for crushing and grinding gypsum. H P. 3.
2. One shifting cylinder of wooden frame fitted with suitable sieves for shifting the ground gypsum. H. P. 2.
3. One motor for the above machines. H. P. 5.
4. One calcining kettle for the plaster.
5. Three rotating discs fitted on table to make the moulds from plaster.

Besides, there should be other tools and accessories for making the moulds.

Kiln house. The jars and carboys etc will be salt glazed and for this purpose no sagger is necessary. The wares are set in kilnson special setters made of fire clay and grog and it is difficult to calculate the Kiln space in advance. But from experience one can say that four kilns of 14 ft. diameter will serve the purpose.

3. SCHEME OF A PORCELAIN FACTORY WITH A CAPACITY OF FOUR TONS OF BODY DAILY.

The planning of the equipments is based on the following daily productions :—

(i) Either, approximately 3500 Insulators with 3000 cleats, cut-outs etc. Or,

(ii) Approximately 5000 cups and saucers with 800 tea pots, milk pots and sugar pots. Or,

(iii) Half and half of both.

There will be following departments, details of which are given later on ;—

(a) Slip House, (b) Making Lines, (c) Sagger House, (d) Plaster House, (e) Kilns, (f) General department and Office.

Besides, there should be space for mould making, sorting space for finished goods and their storage.

The arrangement of the depart-ments should be such that there is a continuity from the storage bins of raw materials to the slip house, then to the making lines, and from there to the kilns. Plaster house should be kept away from slip house, Sagger house may be placed near kilns. Except the slip house and kilns, the other departments will work on one shift. In the slip house the grinding cylinders will work for 22 hours (allowing 2 hours stoppage for the electric motors). The cruhsing section of the slip house will work for one shift and the rest for two shifts. Of course in the kilns, work should go on for all the 24 hours when the kilns are burning.

A. SLIP HOUSE.

This deparment will get the lump stones from the bins, reduce them to fine powder and prepare bodies, glazes and colours from them. Approximate production will be 4 tons per day and will need the following plants :

1. One jaw-crusher $6'' \times 12''$ jaw, capacity 1 ton materials to 3/4" size per hour ; Power-H.P. 9-10
2. One edge-runner with granite runners and base, size of runners $24'' \times 9''$ and base $4' \times 12''$; capacity 1/3 tons 20 mesh material per hour . Power—5 H. P.

These two machines should be housed separately in one shed size $10' \times 20'$ with one motor 18 H. P.

3. Five grinding cylinders of sizes $4'\text{-}6'' \times 4'$, internally lined with silex stones ; capacity half ton stones to fine powder. Power 6 H. P. each. (4 of these cylinders will turn out "Body" and 1 will grind glaze material. On the basis of 50% of the body being stones, the 4 cylinders will give 4 tons body per day and the 5th one will give 1/2 ton glaze in about 60 hours as glaze requires longer grinding.)
4. A set of six pot mills with rotating frame for colour grinding whenever required ; capacity of each pot 4 kilos. Power 2 H. P.

   One 35 H. P. motor for the above 6 machines.
5. One screw blunger, size 7' dia $\times$ 5' high, with screw diameter 20" for mixing one ton of body in one charge. Power 5 H. P.

6. One vibrating screen, size 18″ dia. to seive the body mixture from blunger. Power 1/2 H. P.
7. One electro-magnet to remove iron from body mixture working on 110 or 220 volts D. C.
8. One storage tank for clay slip ; 10′ × 6′ × 6′ with a stirrer. Power 5 H. P.
9. One filter press pump ; capacity 350 gallons per hour. Power 4 H. P.
10. One filter press of 40 chambers, size of chamber 32″ diam. Capacity 3/4 ton, pressed body in 1. 1/2 hours.
11. Either, one vaccuam pug mill, capacity one ton per hour. Power 5 H. P. Or,
    One kneading machine and extrusion press. Power 5 H. P.
12. One 20 H. P. motor for the above machineries with line shafts belting etc.

B. MAKING LINES.

Making will be by jigger and jolley for insulators, cups, saucers and other round shaped articles ; by hand presses for cleats, cut-outs, ceiling roses etc., and by casting process for tea pots, milk jugs, sugar pots and other special shapes.

For the making lines, the following machineries will be required :—

1. Twelve jiggers and jolleys ; Power half H. P. each.
2. Ten potters' wheels ; Power ½ H. P. each.

3. Eight screw cutting machines, hand driven.
4. One powdering mill for dry scraps. H. P. 2.
5. One powder mixing machine for mixing scrap body with water and oil for pressing of cleats, cut-outs etc. Power 1 H. P.
6. One 15 H. P. motor for the above machine.
7. Two hand presses with different dies for pressing cleats, cut-outs etc.
8. Moulds, tools, working benches etc.

C. SAGGER HOUSE.

Round saggers will be made by jigger and jolley for saucers and other similar purposes ; and by hand moulding for other purposes. The following machineries will be required for this department :—

1. One pair of crushing rollers for crushing fire clay and making grog, capacity $\frac{1}{4}$ ton per hour. 5 H. P.
2. One mixing trough for fire clay, water and grog. Capacity $\frac{1}{2}$ ton per hour. 2 H. P.
3. One pug mill for pugging the sagger body ; capacity 1 ton per hour. 5. H. P.
4. One strong-jigger jolley. Power half H. P.
5. One 10 H. P. motor with other accessories.

D. PLASTER HOUSE.

In this section gypsum will be ground on edge runner to about 90 mesh and calcined in iron pans at a

low temperature to provide for the plaster of Paris required for the moulds. The following machineries and equipments will be required :

1. One edge runner with either iron or stone runners, size 24" × 9", and base 4" × 12" ; capacity 5 mds. ground gypsum per hour. Power 5 H. P.
2. One small kiln for calcining ground gypsum.
3. Electric motor of 5 H. P.
4. One iron kettle or pan for calcining the gypsum powder.
5. Sieves and other accessories.

E. KILN HOUSE.

It is not possible to calculate exactly the kiln space required for firing a variety of wares in a factory, but an approximate idea can be obtained if we calculate on the basis of one type of ware. Let us therefore calculate on the production of insulators.

The daily production of the factory is 3500 insulators and an equal number of smaller articles which are generally kept in the spaces left between the bigger insulators. Taking 25 working days per month we have to provide for 3500 × 25 insulators monthly.

Generally nine insulators are kept in a sagger (13 × 13 × 8 inches outside dimensions). Therefore we need 9723 sagger space per month.

From a pair of down draught porcelain kilns one can expect three firings per week ; but giving allowance

for repairs, one can easily take ten firings per month from two kilns. Hence 973 saggers must be accommodated in each firing.

Taking the volume of each sagger as 0.8 cu. ft., we require 0.8 × 973 or 778.4 cu. ft. of sagger space in each kiln; and giving an allowance of 15 per cent for the spaces left open for the flow of hot gases, we need 895.2 cu. ft. of space in each kiln

It is advisable to construct high temperature porcelain kilns not higher than 10 ft. in order to avoid excessive sagger loss. Hence the floor area of the kiln would be .8952 sq. ft.

Hence a pair of kilns with 11 ft. inside diameter and 10 ft. height will serve the purpose but when biscuit firing is also needed for assorted wares another similar kiln will be required,

Besides the above mentioned three kilns, one muffle kiln and one open top kiln for calcination of quartz will also be needed. Approximate number of workers required in each department are given below.

A. *Slip House.*

The chrushing section consisting of jaw crushers and edge runners will work one shift per day and will need two men for that. The five grinding cylinders will work for 3 shifts. The rest of the slip house will work 2 shifts and will need ten men in each shift. Besides, there should be one oilman in each of the three shifts to look after the grinding cylinders which will work for 22 hours.

B. *Making Lines.*

One Maker with two assistants can make an average of 500 Insulators per working day of 8 hours. So, there should be 7 Makers with 14 assistants to make 3500 insulators, besides, two men to make cleats etc. When the insulators are made and dried, they will have to be turned and finished for which 10 men working on the wheels with five assistants will be sufficient.

For cups and saucers, the average production of a Maker with one assistant per working day of 8 hours is either 1000 cups or 800 saucers, so, there will be about 16 Makers with 16 assistants for this purpose. There will be, besides, three men for pressing and joining handles. For casting tea pots etc, four castings can be obtained per mould in 8 hours and there should be about 4 men for this work. When the articles are dry and properly finished, they will be glazed. Mostly, women are employed for this light job and glaze about 1000 pieces in 8 hours. There should be, therefore, about five workers if only insulators are made and about fifteen workers if cups, saucers etc. are made.

N. B. The making, finishing etc., are generally done on a contract basis.

C. *Sagger House.*

On the basis of sagger life being about 5 to 8 firings, daily production of sagger will be about

100 of standard size (13″×13″×8″) or its equivalent number. There should be about 8 to 10 men in the sagger house and a good reserve of all shapes of saggers should always be at hand, as otherwise, kiln firing may be delayed for this small neglect with consequent loss.

D. *Plaster House.*

Approximately, about 2 mds. plaster of Paris will be needed per day, so that, only one worker can successively carry on the grinding, seiving and calcining. There should be three or four skilled workers for making moulds etc.

E. *Kilns House.*

One Fireman with three assistants will look after the firing in each shift. They will need three more men when loading or unloading.

N. B. Besides, there should be a general department for bringing raw materials, carting away rejected pieces, ash etc.

WAR MATERIALS

1.	China clay	...	55 tons		per month.
2.	Felspar	...	30	,,	,,
3.	Quartz	...	30	,,	,,
4.	Marble	...	1	,,	,,
5.	Fire clay	...	25	,,	,,
6.	Gypsum	...	3	,,	,,
7	Coal	...	45	,,	,,

Chemicals for glazes and colours will depend upon the production of coloured and decorative articles.

Remarks.

This scheme has been designed to manufacture about 50,000 line insulators per month together with several thousand other smaller electrical goods like switches, cutouts, ceiling roses, cleats, etc., and about an equal number of hollow table wares like cups, saucers, tea pots, feeding cups, hospital requisites etc. The making will be done both by machine turning and casting in plaster moulds.

The amount of capital required will be about two acs of rupees for the machines, tools and other sundry articles but for land, buildings and working capital, another three lacs of rupees will be necessary.

About four to five acres of land near the railway station will be quite suitable for future expansion. The site may be selected near a big city to get the facility of marketting the products and electric power needed for running the factory.

APPENDIX

1. Clay deposits in India.

Clays are naturally occuring mineral substances, composed mainly of alumino-silicates, but usually mixed with indefinite amounts of sand and other minerals. The peculiar characteristic properties of clays are, they become plastic when wetted with water, and when dried and fired to red heat, they acquire a hard stone like form. Clay is a product of de-composition of rocks rich in alumino-silicate minerals. The decomposition may be brought about by superficial weathering due to the atmospheric agencies or by the action of hot vapours or fluids emanating from underground sources. Clays originated from weathering are hardly deep-seated, whereas those due to the action of underground agencies have revealed better material at depths. Whatever be the origin, a clay must possess that characteristic property called "plasticity" which makes it so useful. Clay in finely divided state, either natural or produced by grinding, can therefore be easily moulded into any shape which it retains on drying.

When very pure, the chemical compositions of some clays correspond roughly to the formula :—

$Al_2O_3.2SiO_2.2H_2O$. and these clays are known as kaolins or China clays. These pure clays are white or nearly white in colour and largely used in the Pottery industries. Ball clays are very plastic purer clays but they contain a little more alkalies than average kaolins and hence fuse at lower temperatures than the kaolins. The colour of natural ball clays is generally grey but on firing the colour becomes nearly white. The ball clays are used in stone-ware and earthen-ware bodies. The fire clays are less pure than kaolins and generally contain variable amounts of free silica and small amounts of iron compounds and alkalies. These clays are more refractory than the ball clays and are used largely for making fire bricks etc. The colour of fire clays is from grey to black due to organic impurities which burn out on firing. A good fire clay must be plastic and should not fuse under 1700° C in oxidising atmosphere.

WHITE CLAY DEPOSITS IN INDIA

Assam. In the Garo Hills, beds of kaolin or kaolinised gneiss are found below the coal-bearing sandstones, at the base of the Eocene beds. These beds spread from the valley of Kalu up to Tura and again in the Simasng about Siju. These beds are well-developed in the valley of Rongtham, specially south of Naringgiri and S.E. of Dobu and also near Nengkhara Agalgiri and Boldakgithim. The kaolin from all these

places is supposed to be of good quality. (Rec. G. S. I. 1936, 71, p 34). In the western portion of the Garo Hills the clay beds, 2 to 3 ft. thick, occur west of Sumesari with their best development near Tura. This material has been regarded as white fire clay and is quite suitable for pottery.

In the Khasi and Jaintia hills, kaolin is associated with the Cherra sandstones. It is also found as decomposition product of the elspar of geneisses and granites. Small deposits of beds, 3 to 5 ft. thick, occur north-west of Laitkseh. This kaolin is iron stained and pisolitic in structure (Rec. G. S. I. 1939, 74,p. 35).

A large deposite of clay has been reported from the banks of the Dora river in the Lakhimpur district by Crookshank, 1939.

Siliceous clay has been reported from the Shillong district.

In the extreme north east at Brahmakund and at Doramukh, a few miles south of Parghat, there are thick deposits of white clay resting on quartz bed ; these are apparently river deposits.

Bengal. At the debouchure of Sakkam river in Darjeeling district, there are beds of white clay. A similar material is used in Sikkim for white-washing.

Kaolin in large quantities due to the decomposition of the felspar of the porphyry is reported to occur at Makkiari, 7 miles south of Raniganj on the Bankura road (Crookshank, 1939).

In the Birbhum district, the occurrence of a kaolin deposit has been reported, 6 miles north of Sainthia. The clay is of poor quality.

Bihar. In the Rajmahal Hills, there are various places where kaolin has been found. The clay is quite white and free from quartz and other mechanical impurities. It is of the powdery not very plastic variety and is very suitable for the manufacture of all kinds of porcelains and china wares.

The deposits are exposed and worked at severa places mainly by the loca people, the chief centres at present are :—

Katangi, near Baskia about 45 miles by road from Muraroi Ry. station. The beds here are supposed to be formed from the decomposition product of felspar in the fundamental gneisses and schists, and is visible for a length of 40 yds. and to a depth of 15 ft. without any base being exposed.

Kárnpur and Dodnani, are about 40 and 35 miles form Rampurhat. Here the deposits seen are much less in extent although no limit of depth is yet found out. They are worked by the local people in tunnel form and used mainly as a white wash for their houses.

Patharghatta, situated at the base of the hill facing the river Ganges. It is about 6 miles from Colgong station on E. I. Ry. The total thickness of the bed as xisting in this locality is about 180 feet and they are

capped by a little outcrop of volcanic rocks. There is however evidence of wide extent of clay beds under the hills. The amount of quartz grains present in this clay is considerably higher than in the former cases, and the percentage of clay content is also a little lower about 15 to 20 per cent. In 1860 a large pottery works flourished in this locality using only local materials, as some excellent felspars were found near Lohunda about 20 miles from patharghatta where good coal was also obtainable.

Kadesh hill about three quarter miles distant from a smaller hill of Patharghatta, though disconnected from each other, they are identical in geological structure and have undoubtedly at some former time been continuous with each other and with the rocks now forming the Rajmahal Hills, eastward.

Mangal Hat. The clay is obtained by washing the white Damuda sandstone and is very plastic. The Mangal Hat kaolin is remarkably free from mica but in other places more of this mineral is frequently present. In many places on the western side of the hills the percentage of kaolin in the sandstone is much higher but they are not so free from mica like the Manghal Hat or Pirpahar clays. The yield of clay is generally between 20 to 25 per cent.

Samukia and Kathuria are within ten miles from Banka subdivision of Bhagalpur District The clay deposits here are very rich, yielding about 30 to 40

per cent of very good plastic kaolins of high quality. The deposits are not properly worked on account of the difficulties of road and transport.

A fair quality clay occurs at Kowakola in the Nawadha subdivision of the Gaya district.

In Manbhum kaolin occurs associated with schists in the southern portion of the district near Rajabasa and at Dandudih, Tamakhun and Balrampur. The clay from the last named locality is used as paper filler, Kaolin has also been worked at Taldih and near Tundi (Mem. G. S. I., 1942. 78, p 105).

In the Monghyr district, good quality clay occurs near Nawadih and near Pirpahar (3 miles east of Monghyr). The Pirpahar clay is suitable for pottery and also as a filler.

In the Ranchi district, clay (lithormarge) occurs in large quantities on Serendag plateau, 50 to 60 feet below the laterite and at Dischmatia Pat (5 miles west of Lohardagga). On the Bagru plateau occous a pinkish variety of kaolin. It is fine grained and burns buff. The deposit seems to be fairly large (Trans. Ind. Cer. Soc., 1942, 1, pp. 94-107).

In the Singbhum district, kaolin occurs in the granitic masses or in the rock adjacent to the granites, The important localities are near Hat Gamaria, Kashmandu, Katahpara, Mahuldiha, Telaipi, Karanjia, Pandrasali, Majri, Madkumhatu, Metiabandi, Kharhidungri and Dharadin. Of these deposits, those near Hat Gamaria have produced better quality kaolin and

according to Dr. Dunn (Mem. G. S. I. 1942, 78, p. 106), they extend to a depth of at least 70 feet but the ratio of material excavated to refined clay is only 18 to1.

• *Orissa and Orissa States* . China clay occurs in the Cuttack district at Naraj and Brahmanbil. The Brahmanbil clay is plastic, gritty and fusible. The Naraj clay occurs in beds from 1 to 7 ft. in thickness and underlies the sandstones. It is coloured grey but burns white. It has low shrinkage and high refractoriness.

In the Puri distirct, in the Barhapati Reserved forest (Khurda sub-division) on a hill known as Hhari Mundia east of Barthali Mundia, a bed of white clay occurs overlain by a 12 ft. thick bed of sand-stone. The clay is fine to sandy and has good plasticity. It does not fuse at 1400.C. nor cracks at that temperature and burns light grey. It is being used as a filler in textile industry but can also be used as a refractory clay. White clay of similar type occurs at Bharthpur and Jagannathprasad. Both these clays are white soft, and possess good plasticity. They stand the temperature of 1400°.C. well without fusing or cracking. They can be used for refractory purposes also (Econ. Geo. Orissa. 1943).

In the Ganjam district, white china clay deposits occur in various localities e. g., Gundaranga, Polosara and Buguda. The clay from Gundaranga is soft, gritty and has moderate plasticity. When raw, it has light yellow colour but burns white. It stands the temperature of 1400°.C. without fusion and has a low shrink-

age. The Polosara clay also stands 1400°.C. temperature but burns yellowish grey.

In the Koraput district, a deposit of clay occurs at Deodra, 12 miles W. N. W. of Nowrangpur. The clay is cream white and soapy to touch and possesses a good plasticity. It stands 1400°.C. heat well and burns white. The clay occuring at Buguda is mixed with little graphite and is gritty. However, it is plastic, burns white and does not fuse at 1400°.C. nor cracks at that temperature. Its shrinkage at that temperature between 10 to 5 p. c. White clay also occurs at Pukkili, Nuagam and Ambodala. Clays from all these localities are white and stand the temperature of 1400°.C. well.

In the Sambalpur district, kaolin occurs at Deasar, Paharsigira, Ghichamarua, Sagunpali, Chuhukitikra, Banjipali, Piplipali and Baresinghari. Out of these the clays from the first five localities are gritty and stained with ferric oxide. The one from Chuhuikitikra is gritless and plastic and the deposit deserves careful prospecting. These clays have so far been located in pockets but it seems larger amounts will be available on more prospecting. The clay bed at Baresinghari occurs in great thickness and has been quarried also.

In the Saraikela State, the clay occurs at the following localities ; Chapra, Ghagi, Mundakati, Bharatpur, Gangeruri, Ramgmatia, Koludih, Jaspur and Samrah. The clays are whitish, plastic but gritty.

Regarding the quantity nothing can be said (Mem. G. S. I., 52 and 69).

In the Mayurbhanj State, the deposit of clay occurs near Baripada and are overlain by laterite. The clay is plastic and slakes in water slowly. At bright red heat it does not fuse but becomes hard. According to Vredenburg it constitutes excellent material for pottery (Rec. G. S. I., 31).

In the Raigarh State, clay occurs near Khursia Ry. station. On washing, the material yields 90 p. c. of good kaolin.

United Provinces. There are white burning clay deposits near Nainital, Almora and Mirjapur.

In the Banda district, a deposit of clay, similar to those found in the Sohawal State of Central India occurs in the vicinity of Lakhanpur, about 3½ miles from the Tikuria Ry Station. The clay is interbedded with yellow ochres and is white and plastic. It can be used in the manufacture of good pottery (Tr. Ind. Cer. Soc., 1).

Delhi Province. Clay mines are worked at Kusumpur about 10 miles from New Delhi, and a short distance of this place north of Kutubminer another similar deposit is at Buchara near Lota river in the Aliwar Hills.

In Gwalior State, kaolin occurs in many places in the Nakum hill and two other small hills north of Antri. The clay from the former place is used for making pottery wares.

The Punjub. A deposit of highly siliceous, white burning clay occurs 4 miles from Diljabba Ry. station in Chakwal tahsil. The clay is white in colour and refractory and suitable for pottery manufacture.

In the Mainwali district, at a locatity about 3 miles from Musakhel, there occurs a greyish white plastic clay. The clay burns grey and fuses at about 1250°.C.

At Ratucha, a small village in the salt Range about 6 miles from the Ry. station of Kheora, a white burning and very plastic and refractory clay is obtained. The raw clay is dull white in colour but burns white at 1100°.C. As reported by F. C. College Lahore, (Jr. I. C. S. 1932) the clay is very suitable for stone wares, white tiles and earthen ware bodies.

A white burning, very plastic and refractory clay occurs in Dera Gazi Khan. The deposits can not be easily worked since they are situated at a distance of 36 miles from the nearest station.

At Mahilpur in Gurgaon district, there is a deposit of white burning kaolin with good plasticity and very high refractoriness. This clay can be used for all white pottery wares.

In the Chamba district, a deposit of white burning clay is reported from Dalhousie. This material can withstand much heat.

N. W. Frontier. In the Dera Ismail Khan, on the southern and northern slopes of the spur of Tumani Gundai, 1¼ miles S. S. E. of Paniala, occurs a bed of sandstone, containing a large amount of clay material.

The clay is remarkably low in fluxing agents and fuses above 1 500°.C. It may be used for the manufacture of low grade fire-bricks. The material from the northern slopes contains probably gypsum as it cracks at 1400°.C, though it does not fuse at that temperature (Rec. G. S. I., 1940, 75, p. 23).

In the Kohat district, a sample of clay, received by the Geological Survey of India was tested and was found to be suitable to be used as a filler. The locality is not known.

In the Mardan district, the clay found at Jahangira is fairly plastic but contains 21 p. c. of Mg.O. It is suggested that it may be used in the manufacture of electric insulators if the colour is no bar.

In the Hazara district, clays suitab'e to be used as china clays occur at Kagan and Konsh Valley.

In South Waziristhan, clay occurs in the hills between Kutmar Sar and Preghal. The colour of the clay is white.

Kashmir State. Large deposits of kaolin constitute the lower portion of the Bauxite series of the Jammu Province, especially at Chakar, Sangarmarg and Salal. These kaolins are sometimes white and powdery, but more generally dove-coloured or of various tints of pale grey, cream colour and occasionally darker neutral tints. They are generally soft but in their passage upwards into more aluminous bauxitic clays they increase in hardness and assume a glossy surface which resists erosion and takes a high polish. Another variety

of kaolin, locally known as "makol" occurs in small pockets on the exposed surface of the Great Limestone formation of Jangal Gali area. This clay possesses the requisite qualities of plasticity before and of hardness and rigidity after firing, whereas kaolins obtained from under the bauxite require proper exposure to weathering, with grinding and sufficiently long slaking to make them suitable for pottery purposes.

Hyderabad State. An important deposit of high grade kaolin, suitable for ceramic purposes has been reported from Chintrala in the Nalgundā district. It occurs in beds of considerable thickness in an area of highly decomposed pegmatites. The estimated amount of clay at Chintrala is about 250,000 tons. China clay of very good quality also occurs at Kamthana, about 7 miles S. W. of Bidar. This clay is being used as a filler in the paper industry. Kaolin also occurs at ½ miles S. E. of Srirangpur, 2 miles east of Kundrug, in the Pargi taluk and also in association with phyllites about a mile S. S. E. of Maddagudem in the Narsampet taluq and at Miryalpenta in the Yellandu taluk of the Waranngal district. (Hyd. Geo. Surv. Bull. no. 2, 1943).

Rajputana States. In Ajmere-Merwara, deposits of clay occur at Goridung, on a spur of Taragarh hill, at Ajmer and at Machla hill, 3 miles south of Mailan. The Machla material is dirty-white but on washing yields a perfectly white and highly plastic clay. Its chemical composition approaches very

nearly that of pure kaolin. More than 6,000 tons of clay are available and the cost of mining will be low. A ferruginous variety also occurs at this locality. The Goridung clay is contaminated with biotite and it is very difficult to free the clay of this impurity. However, this clay cannot be used either in textile or high grade pottery manufacture. (Q. J. G. M. M. Soc. Ind. 1937, 11, p. 11, and Trans. G. M. M. I. Ind. 1935, 29 p. 347).

In the Jodhpur State, kaolin occurs on the western and northern slopes of the Masuria hill near Jodhpur as the cementing material of a coarse white sandstone, which on levigation yields a very fine-grained white clay resembling Cornish clay. Similar deposit of clay occurs near Gehun in the Malani district. Kaolin deposits have also been found in association with granites and pegmatites of this state. Many localities have been mentioned by K. L. Bhola (Trans. M. G. M. I. Ind. 1942, 38, p. 53), the more important of them being near Rani Ry. Station, at Jeoria near Pali and at Kharda-ki-chani near Kairla Ry. Station.

In the Bundi State, kaolin has been extracted at Manak Chok, from the junction of the Upper Rewa sandstone and jhiri shales. The deposit though big seems to be of low grade kaolin.

In the Kotah State, china clay occurs at Barada and Sirol (khal) or Khanda Sirol. The clay is of good quality and an analysis showed 41.57 per cent of alumina and 42.78 per cent of combined silica. It is

quite suitable for porcelain and pottery (Rep. Geol. Surv Kotah, 1942, p. 11).

In the Jaipur State, kaolin occurs near Buchara in Torawati, near Rasnu and Mathasur. The clay of Rasnu occurs in a bed 60 ft. thick but is banded with quartzite. On washing, it yields good quality clay suitable for use in textile. The washing of sand from Sawai Madhopur also yields 30 per cent of good white plastic and siliceous clay (Tr. Ind. Cer. Soc, 3).

Travancore State. Excellent type of clay occurs at Kundara, 8 miles east of Quilon, in the Varkaola formations. It is a primary clay, very white and plastic and very refractory. It contains small percentage of TiO_2 which is much useful for its being used in the textile industry. The Travancore Government have established a fine plant for quarrying and washing this clay. This clay is very fine and an elutriator test showed that it contains 93.9 per cent of particles of the size between .0085 mm. and .00001mm. and that it contains a larger percentage of fine particles than in the English clay (Travan. Govt. Publ).

Mysore State. In Bangalore district, clay occurs in the Hoskote and Malur taluks at Hattaki area, in area between Tavarkere Lingapur, in Bhuvanhalli area, Nandagudi and White Field area. At all these localities, white and plastic clay occurs beneath an overburden of 3 to 5 ft. These white clays are mixed up with red and yellow ones. The total quantity at

all these places is estimated to be 1870 tons only. In the lateritic region of the same area, deposits of clay occur at Injanhalli, Tavathalli, Jadgenhalli, Solur, Bavanhalli. These clays are white and plastic and burn buff. From all these areas it is estimated that 1775 tons of clay can be obtained (Rec. Mys. G. D., 1933, 32). In the Hoskote taluk good quality clays occur at the Venkatapur, Wabsandra, Kamblipur, Golhalli and Nandagudi. These clays are white, plastic and gritty. The purest variety of clay free from iron from the Golhalli deposit is being used for the manufacture of high tension insulators in the Government porcelain factory at Bangalore (Q. J. G. M. M. Soc. Ind., 1942, 14, p. 177). China clay also occurs at Honganhalli, Toranhalli and in the neighbourhood of Tyakal near Narsipur. These clays are white and plastic.

In the neighbourhood of Bangalore, clay occurs at Peenya, Sankey's Reservoir area and at the 5th mile-stone on the Nelamangale-Dadbalapur road, and at Bhimasamudram. These clays are plastic, white gritty and to certain extent micaceous. They burn buff.

In the Mysore and Kodur districts, clay is found at Melkote in small pockets. It is supposed to be of primary origin, and burns dark grey at 1100.°C. Clays also occur at Koppa, Hoskoppa, Asagod, Bavalpur, Kakkod and Kirki. These clays on washing are likely to yield good quality materials.

In the Hassan district, clay occurs due to the decomposition of pegmatite veins in the Appenhalli area and also at few other places in the neighbourhood of Appenhalli. The total quantity from this area is estimated to be 10,000,000 cu ft. Similar occurrences of such clay are also recorded from the neighbourhood of Nandihali village. White kaolin to the extent of about 11,00,000 tons are estimated to occur here. (Rec. Mys. Geol., Dep., 17 and 32). In the Kolar district, an inferior grade of clay occurs in the neighbourhood of Karadibande where the decomposition of gneiss has given rise to it. The area lies 7 miles north of Mallur Ry. Station. Clay also occurs at Vokkaleri.

In the Shimoga district, a deposit of white kaolin occurs at Maradi, about 9 miles north of Kippa in the Tirathalli taluk. The clay is mixed up with undecomposed and partially decomposed granite. Similar clays occur at Nagadavalli and Mellagi also. The quantity of fine clay from these deposits is estimated to be about 60,000 tons (Rec. Mys. G. D., 1938, 37).

In the Kodur district, clay occurs at Kakkod, melloppa, Haralcudige and Kasguli. The clays from these localities are derived from the decomposition of gneiss or pegmatite. They are plastic and it is estimated that about 12,000 tons of good materials will be available from the last three localities.

Madras : In the Chengleput district, white and fine clay occurs at Sripermatur in unexhaustable amount in the Rajmahal series in the valley of Attrampakkam

stream, at a distance of 8 miles from the railway and about 25 miles from Madras. The same variety of clay also occurs at Coopum near Perumalput. At Ambattur two varities of clay occur under the laterite beds. One variety is white and it burns also white. The other is slaty in appearance when raw and burns buff. Another deposit of white clay also occurs at a distance of 22 miles from Ambattur Ry. Station. The thickness of the over burden is 10'-15'. The clay burns buff and is supposed to be refractory.

In the Godavari district, good quality white clay occurs near Rajmahendri. This clay is white and plastic and appears to be refractory. On burning it shows small shrinkage and remains white. (Crookshank, 1939). At Peddapuram, near Samalkot railway station, a deposit of white clay occurs intermingled with red clay in granites. The clay is lean and does not show any sign of vitrification at 1250°C. At Jaggampet, 10 miles from peddampuram, the washing of clay stones has yielded 16 per cent of white clay. This clay shows low plasticity and burns white. At a distance of 6 miles from the Rajmahendri Ry. Station, a deposit of white clay occurs at Punyakshetram. It is plastic and breaks with a conchoidal fracture. It vitrifies at 1250°.C. and burns buff. At Bommuni Metta, 2 miles from Rajmahendri, a white clay has been found.

At Bhogapuram, 5 miles from Chodavaram, white siliceous kaolin occurs. It burns slightly buff and does not soften at 1250°.C. A small deposit of impure white

clay occurs at Cheedigummala, 3 miles from Narsipattam and on Krishna-Devpet road. Siliceous but plastic clay occurs at Dasannapet in the suburb of Vizagapatam. The clay burns light buff and softens at 1250°.C.

In the Guntur district, a bed of white clay mixed up with quartz is reported to occur at a place about 4 miles from the Guntur Ry. Station.

In the South Kanara, white clay occurs at Puttur. The clay burns white and is reported to be suitable for pottery manufacture (Pillai, D. S. 1934).

In the North Arcot district, white clay occurs at Tiruppankadu in beds 17' thick. The deposits are situated 6 miles from Canjeevaram Ry. Station. A bed of white clay 9' thick occurs at a depth of 21 ft. at Pallur village in the Arkonam taluk. Kaolin is also reported to occur at Kuditanapalli, 2 miles north of Gudipali Ry. Station.

In the South Arcot district, white clay occurs at two localities, at Pannikuppam 3 miles from Panroti and at Kumalapatta. The material from Pannikuppam contains 94·34 per cent of clay substance and burns slightly buff. The deposit is extensive. The Kumalapatta material lies under an overburden of 4'—6'. At Putturi also a 30' thick seam of white clay occurs. This locality is 31 miles from Pondicherry.

In the Nellor district, the decomposition of pegmatite has given rise to a bed of kaoline 20' wide at Malatippa about 1 mile from the Kistama mica mines

(Rec. G. S. I., 1934, 68, p. 31). A deposit of white clay is also reported to occur at a distance of 23 miles from Nellore and 5 miles north of Podalakuru in Atmakur taluk. The clay is plastic and burns white. Good quality kaolin also occurs at Prabhagiripattam in this district and a small quantity of good kaolin, suitable for bleaching purposes has been obtained from the Victoria China Clay Mine (Crook-shank, 1941). In the Kavali taluk, a deposit of white clay occurs in Kavali-Peddapavani area. The clay is lean and burns buff (Pillai, D. S. 1934).

In the Bellary district, siliceous and ferruginous clay occurs at Copper Hill near Hatti, 10 miles from Bellary. The material contains 3.87 per cent of iron. It can be used in the manufacture of low grade pottery. The overburden is thick.

In the Cuddapah district, a deposit of white kaolin from Buddayapalli, N. E. of Cuddapah Ry. Station is recorded. A deposit of white clay occurs at Hatsavaram, 5 miles from the Rajampeth Ry. Station under 10′ – 15′ thick overburden of red soil. The clay seems to be less refractory as it contains about 5.74 per cent of alkalies. In the Badvel taluk at Varikunta, about 30 miles from the nearest railway station, white clay suitable for the manufacture of potteryware is reported to occur.

In the Ganjam district, a 9 ft. thick bed of clay is reported to occur at a depth of 17 ft. at Chicacol. (Pillai, 1934)

In the Karnool district, a bed of kaolin occurs in Nandyal taluk, about 11 miles from Gani. This kaolin may be used as fire-clay. At Giddalur a bed of white clay has been traced to a distance of 3 miles from the railway station. The alkalies in this clay are 7.05 per cent. The clay is siliceous, plastic and is of faintly light buff colour. According to Pillai, the material is suitable for high grade porcelain.

In the Malabar district, the decomposition of pegmatites near Midland Estate (Wynand taluk) has given rise to a good quality kaolin at the 61st milestone on the Mysore road. The bed is 20 ft. thick and occurs at depth of 8 ft. The clay is micaceous but yields good material when washed. In the Palghat taluk, good quality white clay occurs at Parli. This clay is supposed to be suitable for ceramic wares.

In the Salem district, white clay is reported to occur in the Hosir taluk at Punnapalle, Chinna, Kolkonadapalle and Belagondapalle near the Mysore State boundary and at Yediayenallur near Mathigiri. The clays from Punnapalle and Chinna are reported to be white but gritty.

In the Tanjore district, white clay occurs at Vallam, 7 miles from Tanjore and also at Santhaniarkoil 8 miles from Arantanggi Ry. Station. Another deposit of white clay occurs at Surendai, 8 miles from Pavurchatram railway station.

In the Trichinopoly district, a bed of white clay occurs under an overburden of 35 ft. at Vilangudi, 15 miles from the Ariyalur Ry. Station. The clay burns

white and on washing yields 48.12% of clay substance. White clay also occurs at Utacoil and between Parany and Kauray (Pillai. D. S., 1934)

Bombay : Castle rock, in Kanara district, contains some kaolin deposits. Laterite is also found over the hills having a thickness from 10 to 30 feet and probably more in the valleys. The Kaolin is found below the laterite and on the gneisses. The chief occurence is 1½ miles west of Castle rock station The length of the exposure is about 236 feet The kaolin is pure white in patches and stained red at the eastern and western extremities, but after firing the samples vary from light grey to white. The plasticity is good and the clay is very suitable for pottery.

Ratnagiri Dist. The deposit of kaolin near Malvan is to be found by a small water course about a quarter of a mile south of the village Kumbharmatt some three miles east of Malvan. All the pits occur in a small valley and cover an area about a quarter of a mile in length and some 400 ft. wide. The kaolin is slightly plastic and cracks a little on being fired.

Belgaum Dist. This deposit is at Karalgi, situated some three miles from the railway station of Khannpur. The clay is nonplastic and with a brownish colour, which vanishes on firing to a very pale cream or almost white. It does not crack on drying or on firing to 1050°C. as in the case with the previous one. The deposit is of the order of 4000 tons and yields about 36 per cent of fine clay after washing.

In the North Kanara district, at the foot of a laterite hill at Kulkod, one mile east of Honawar on the bank of the Saraswati river, occurs a big deposit of fine grained white china clay. Clay also occurs at Honawar. According to C. P. Shah, this clay cannot be used in the textile industry but can be suitably used in the manufacture of common earthenware and porcelain.

In the Thana district, a deposit of white and plastic clay occurs under sandstones near Nala Sapora

In the Idar state, the surface disintegration of granite has given rise to small deposits of clay in this state. Such a deposit occurs at Eklara. The clay found here is of good quality, stands the temp. of 1400°C well without cracking. The deposit is quite big. The clay is suitable for the manufacture of pottery and porcelain (Mem. G. S. I., 1921. 44, p. 146).

In the Baroda State, a three ft. thick bed of clay overlying the Tertiary sandstone occurs in Vijapur Taluk about 1 mile S. E. of Ransipur. This deposit is the continuation of the one found in the Idar State at Eklara. The clay is plastic and suitable for pottery manufacture (Mem. G. S. I., 1921. 44, p. 147).

Central Provinces: In the Jubbulpore district a good variety of white clay occurs in the Chhota Simla hills near Jubbulpore Ry. Station. This clay is interbedded with white soft sandstones of the Jubbulpore group of the Upper Gondwana formation. These deposits are extensive with variable thickness, the maximum thickness being 50 ft. at this locality. The colour of the clay is white or pale grey. It is highly plastic and refractory

and has a low shrinkage. On heating to a temperature of 1400°C it becomes a hard mass and retains the white colour. The chemical composition of this clay approaches that of kaolin (Rec. G. S. I., 1889, 22, p. 140).

Another deposit of clay probably an extension of the above, occurs at Saptal at a distance of about 2 miles from Jubbulpore on the Jubbulpure-Nagpore road. The clay is of good quality and burns white.

At Lametaghat, 9 miles S. W. of Jubbulpore, there is a deposit of white to cream coloured clay. According to Sen Gupta, (Q. J. G. M. M. Soc. Ind., 1943 15, p. 99) the clay approaches pure kaolin in chemical composition and burns white. It shows no signs of fusion at a temperature of 1200°C. and is suitable for the manufacture of China ware.

In the Chanda district, Crookshank reports the occurrence of kaolin at a distance of 13 miles due north of Chanda. This material is reported to be suitable for the manufacture of porcelain.

In the Drug district, kaolin occurs in the Sanjari tahsil at Hithapahar, Jungera-kalan and Bhandaritola. These clays are supposed to be of good quality. The Hithapahar clay is free from gritty matter and is fairly plastic. Fusibility is below 1400°C. It is usually exploited for ceramic purposes (Rec. G. S. I., 1938, 73, p. 32). At Harratola a gritty, fine grained and plastic clay (used for white wash) is found to occur in large quantity in the shales of Cuddapah age and at Chandia, fine grained plastic clay is extensively excavated for

white washing purposes. The material burns grey and does not fuse at 1400°C. (Rec. 1939, 74, p. 34.)

FIRE CLAY DEPOSITS IN INDIA

Assam. In Makum coalfields in the Lakhimpur district, there are some deposits of fire-clays. These are contaminated with coaly matter and iron pyrites which make them soft at lower temperature. They have been tested at temperature sufficient to melt iron but at this temperature the clay shows signs of softening to a certain extent. It is hoped that when these clays are washed free of these impurities or samples are taken from depths, the refractory qualities will improve.

Fire clays also occur in Khasi and Jaintia hills at Jawai which is an inaccessible place at present. Samples of this material have been tested by Messrs. Burn & Co. and found to make excellent fire-bricks capable of withstanding great heat. (Bid. Ind. Geol. and Phys. Geog. Pt. IB, 1918, p. 146).

In the Golaghat district, fire-clay occurs at the following localities. 1. Fall of Nambor river, 2. At Bore Pohar and 3. Fall of the Dhansiri river.

Bengal. In the Burdwan district, the coal measures of the Barakar series in the Raniganj coal. field, contain below the coal seems a number of fire-clay beds. The principal areas where such beds occur are :—Garphalbari-Dahibari, Damagoria, Radha-ballabhpur, Shuamdi, Pohargora, Ramdhara, Kanta-pahari and Garh Dhemo Churilia. These are all

supposed to be good quality, typical fire-clays which can be used in the manufacture of refractories.

Gee records other samples from Gourangdi and Patlabari which are typically good quality fire-clays (Mem. G. S. I., P. 2, 61). Bates (1923) records the occurrences of good quality low fusibile fire-clays from Durgapur and Raniganj. The Raniganj clay occurs at Ronei. A carbonaceous fire-clay also occurs at Lutcheipur.

The deposit of fire-clay at Radhaballabhpur in the Asansol subdivision is plastic, gritty and reddish in colour. It does not fuse at 1400°. C. but the colour becomes greyish white (Q. J. G. M. M. Soc., 1940 Bull. 4).

Bihar. In the Palamau district, deposits of fire-clay occur at Rajhara in the Daltonganj coal-field. The seam is about 10 ft. thick but lime nodules have to be removed. It is good plastic fire clay and is used for mixing with harder clays from the Raniganj coalfield.

In the Monghyr district, clays suitable for pottery ware occur near Nowadih and Pirpahar, 2 miles E. of Monghyr. They are presumably associated with Archean rock

In the Manbhum district, fire-clays occur in association with the coal seams of the Jharia and Raniganj coal-fields. The best clays occur in the Barakar series. In the Jharia coal-field, the clays occur close to the edge of the coal-field in Jharia, Pathardih and Tisra areas. In the Raniganj coal-field, fire-clays occur near the Damodar and Barakar rivers. A

deposit of clay similar to Raniganj fireclay occurs at Malaldhi close to the railway station. The thickness of seam is reported to be from 1′ to 3′. Another deposit of fire-clay suitable for fire-bricks has been reported by Fermor, from south of Rajabasa (Rec. G S. I, 1935, 69 p. 29)

In the Bhagalpore district and Santal Parganas, Murray Stuart gives a long list of localities where fire-clay occurs. These fire-clay beds occur in the rocks of Damuda age in the coal-fields lying towards the western side of the Rajmahal hills. They all dip at low angles towards east. The thickness of these beds on an average is about 3 ft. (Rec. G. S. I., 1909, 38, p. 38).

Bombay. In the Panch Mahals, a fire-clay bed occurs near Rajpur (Pingli) near Derol Ry. Station in the Kalol taluk. It overlies a bed of Intra-trappean sandstone It is a lean clay with little shrinkage and does not fuse at 1400°. C (Rec. G, S. I., 1938, 73, p. 201).

Kathiawar. In the Lakhtar State, two beds of clay, one above the other, occur near Baglala and Kerwali. The one above is reddish and plastic. It can be used as a fire clay.

Cutch State. A bed of fire-clay occurs at Devpur in the Upper Jurrassic rocks. It is estimated that the clay may be available in large quantities (Crookshank, 1939).

Central Provinces: In the Jubbulpore district, in the rocks of the Jubbulpore stage of the Gondwana

formation, good quality fire-clay has been located. The localities are Dubar and Priparia. These clays are highly plastic and refractory. They can stand well a temperature of 1400°.C, when they become a hard mass (H-6). There are two varities, grey and whitish. Both are fire-clays and can be safely used for refractories manufacture.

In the Narsingpur district, clays in the same formation as above have been located at Salichauka reserved forest, south of Manegoan, Saoneri, Badhai reserved forest, valleys of the Sukker and the Hard between Kodali and Soaneri and at Bijori near Sukhadongar. Out of these, the Saoneri seam is 3′ thick but in the valley near Soaneri its thickness is 4′. The Lalichauka clay is better than the Soaneri clay in possessing better plasticity and not showing any sign of fusion at 1250°.C. These clays are good and suitable for the manufacture of refractory bricks. (Crookshank, 1939)'

In the Nagpur district, an excellent quality of fire-clay occurs at Khairi (Crookshank, 1939).

In the Chanda district, fire-clays are reported to occur in the valley of Wardha river at many localities of which Warora and Durgapur are mentioned. The seam of clay at Warora is 1′ 3″ thick. Both clays contain somewhat high percentage of iron and thus burn red (Mem. G. S. I., 1977, 13).

In the Raipur district, a low grade variety of fire-clay occurs at Murkatola in association with Chandarpur sandstone.

In the Chhindwara district, the beds of the Jubbulpore stage have given rise to some outcrops of fire-clay e. g., near Muria where the thickness is about 20 ft., the clay is fine grained ; about 93.13 p.c. passing through 200 mesh lawn. It is highly refractory and burns buff. It is suitable for the manufacture of refractory bricks (Rec. G. S. I., 1939, 74).

Central India : In the Rewa State, the extension of the same beds as in the Jubbulpore district has also given rise to fire-clays at Amdari, 15 miles west of Umaria, at Baraundi 11 miles west of Umaria, and between Mahanadi river and west of Chandia railway station. The seam is 40′ thick at Baroundi while it is only 4 ft. thick near Mahanadi. The clay is of the same good quality as reported from Jubbulpore (Sinor K. P. Min. Resour Rewa, 1923, P. 183).

Hyderabad State : Heat resisting fire-clay occurs inter stratified with the coal bed of the Barakar series at Pochgaon, 4 miies N. E. of Asifabad railway station. The thickness of the bed is 6 ft. and it spreads over an area of about a square mile. The clay is free from grit. It is supposed to be a good quality fire-clay, (Mirza, K. Hyd. Geol. Surv. Bull. 2, 1943).

Madras : In the North Arcot district, fire-clays occur at Alticoo and at Krishnarajpuram. These clays burn buff and are reported to be capable of standing high temperature.

In the south Arcot district a bed of fire-clay occurs in the Cuddalore beds, on the southern bank of the

Gudalam river, opposite Panroti. This clay is plastic, pinkish in colour and burns buff.

In the Cuddapah district, a bed of refractory clay occurs near Sidhout railway station under an over-burden of 10 ft. The analysis shows 4·57 p. c. iron. The clays supposed to be suitable for the manufacture of refractory materials.

N. W. F. Province : In the Khyber Agency, fire-clay occurs on the Besai ridge north on the Khajuri-plain. It is gritty and lean and does not fuse at 1400 °.C. but shrinks 25 p. c. by volume.

Orissa : In the Gangpur State (E. S. A), Dr. M. S. Krishnan, (Mem. G. S. I., 1937, 71, p. 173) reports the occurence of fire-clay from Kirpsera in the Himgir Zamindari and also at places between Manipahar and Gurpahar. These fire-clays occur in variegated colours and burn white, buff and bluish grey and can withstand a heat of 1400°.C. well.

In the Sambalpore district, fire-clay occurs at Jora-baga, Darlipali, Rampur, Bundia, Katabaga, Kudopale, Chauliberma and Talbira. These clays are hard, plastic and refractory. (Ecom. Geol. Orissa, 1943, pp. 53-57).

In the Cuttack district, beds of good fire-clay varying from 4' to 7' in thickness occur with coal seam near Patrapara. The clay is usually hard, fine and plastic and does not fuse at 1400°.C.

Punjab : In the Jhelum district, a 5' 7" thick bed of fire-clay occurs associated with a coals seam in the Pidh vally just N. W. of Retuchha village, 6 miles from

Khewra. The clay is white and plastic and fuses at a tempaerature of 1600°. C. The analysis shows the clay to be singularly good as a fire-clay and is more refractory than the normal fire-clay (Trans. Min. Geol. Inst. Ind., 1948, 33, p. 273).

In the Kangra valley, deposit of white-burning plastic and refractory clay is reported from Mahilpur.

Rajputana : In Bikaner State, the boring operations at palana revealed the existence of fire-clay beds at a depth of 39ft. and 286 ft. The clay is dirty white plastic and white burning. It remains unfused at 1400.°C.

In the Gwalior State, a big deposit of fire-clay is mentioned by Crookshank (1939) from Raipur, 10 miles from Gwalior and 1 mile from Shivpuri on the Gwalior Light Ry. This clay has been tested and found suitable for the manufacture of fire-bricks.

In the Kotah State, a highly refractory fire-clay occurs at Badara and Sirol (Khal). A mixture of 20 per cent of this clay (burnt) with the weathered clay makes a superior quality of fire-brick. The crucibles made from this at the Baran Glass Works have proved superior to those made by Messrs Burn & Co. at Jubbulpore (Rep. Geol. Surv. Kotah. 1942, p. 7)

REFERENCE

1. Clays in India. By M. L. Misra. Trans. Ind. Cer. Soc. Vol. IV, 2, 1945.
2. Report on the ceramic survey of Madras presidency By D. S. Pillai, 1934.
3. Report on the possibility of pottery manufacture in the province of Bombay. By C. P. Shah, 1941.
4. Pottery Industry in the Punjab. By J. L. Sarin, 1933.

2. FELSPAR DEPOSITS IN INDIA

The minerals known as felspars, from a group which constitute about sixty per cent of the igneous rocks of this world and the clays are obtained from these felspars. In chemical composition the felspars are, alumino-silicates of potash, soda or lime, either singly or in combination of two or three of them. Potash-felspars are known as Orthoclase and michro-cline according to their crystalline formations ; and they vary in colour from transparent blue (Moon stone of ceylon), green (Amazon stone of Nellor) to a deep brown or flesh colour ones largely used in the pottery enamel and glass industries.

The pure soda member of the felspar group is termed as Albite and the lime member as Anorthite. These two members are afterwards found in solid solutions with each other and arbitrary names have been given to intermediate products such as Oligoclase, Labradorite etc.

Although soda lime felspars form parts of most of the igneous rocks they are of little or no economic use. The potash and soda felspars which are found in large masses and crystalline forms are of economic importance specially for the glass and pottery industries for their cheapness and abundance. These felspars generally occur with nice beryl or pegmatite. The quarried material is broken, sown and the felspar sorted out for its specific use. When very finely ground potash felspar can be used as a manure also.

OCCURANCE IN INDIA.

Behar. This province is the richest in India for the ceramic materials like China clay, felspar and quartz. The main sources of felspar are the rich mica belt and the pegmatite veins with little or no mica but rich in felspar. The important places from where felspars are obtained now are :—

Jashidi, Simultalla, Jhajha, Gurpa, Mihijam, Koderma etc. Large amounts of felspar are to be found in the refuge heaps of mica mines as much of the michroclines and albite occure along with the mica which are to be removed in extracting the mica.

Orissa : Orthoclase felspar is obtained in Kalahandi State in Orissa.

Rajputana : Good quality felspars are obtained from various places in the Rajputana States. Notable places are : Ajmere, Alwar, Mewar, Bikaner etc. These felspars are obtained from the quaries of beryl and tantalite.

Madras : Large amounts of felspar is available in the Nellor district from the mica bearing pegmatite belt. Here, as in Koderma area in Behar, large supplies of michrocline felspar are available in the refuge heaps.

Mysore : Felspar occures in the pegmalite veines at Bangalore at Settihalli, Arjunbettahalli and at Holenarshipur.

Central provinces : Felspar is obtained at several places in this province specially at Chhindara, Katni :

SOME ANALYSES OF INDIAN FELSPARS.

No	SiO_2	Al_2O_3	Fe_2O_3	MgO	CaO	Na_2O	K_2O	Loss
1.	63.75	19.01	0.48	—	0.36	1.74	13.91	C.62
2.	64.18	19.46	0.12	0.26	0.10	3.02	12.62	—
3.	67.10	20.44	0.10	—	0.08	11.62	0.24	0.40
4.	65.14	18.71	0.04	0 23	0.34	0.64	11.37	0.42
5.	63 23	21.25	0.08	0.29	0.71	2.61	11.22	0.59
6.	64.52	17.51	0.09	0.98	0 62	3.42	12.38	0 50
7.	64.48	21.18	0 11	0.31	3 15	9.41	—	0.88
8.	42.8	38.C6	—	—	19.31	—	—	—
9.	64.6	19.02	—	—	—	4.35	12.44	—
10.	65.61	18.12	0.08	—	0.29	11.84	4.28	0.08
11.	64.2	21.33	0.05	0.06	0.14	13.61	—	0.6

1. Orthoclase from Kalahandi, Orissa. 2. Flesh coloured michrocline from Chindwara in C. P. 3. Albite from Koderma in Behar. 4. Michrocline from Gurpa in Behar. 5. Michrocline from Meghatari in the Hazaribagh district of Behar. 6. Michrocline from Dhobna near Jhajha in Behar. 7. Albite from Nityakalyani in Nellore district of Madras. 8. Anorthite from Salem in Madras. 9. Michrocline from Settihalli in Bangalore district of Mysore. 10. Albite from Arjunbeth in Mysore. 11. Felspar from Ajmere.

REFERENCES

1. Felspar. By E. Spencer. Trans. Ind., Cer. Soc. Vol. III, Oct, 1944.
2. Chemical analyses of some Indian felspars, M. L. Misra. Ibid. April 1943.
3. Modern Pottery Manufacture. By. H. N. Bose.

QUARTZ

This mineral is found in almost all places from where felspars are obtained, associated with mica and other valuable minerals.

A small deposit of quartz crystals is reported by Dubey and Agarwal in the village Sapotra in Karauli State. This deposit contains some transparent crystals of very small sizes which can be used for wireless receivers. The bigger crystals which are not transparent can be used in other industrial purposes.

Trans. Ind. Cer. Soc., April, 1944.

BOOKS FOR REFERENCE,

1. The evolution of industrial organisation.
By B. F. Shield.
2. Business organisation. By Sorab R. Davar.
3. Theory and practice of commerce and business organisation. By J. C. Mitra,
4. Economic condition of India.
By P. P. Pillai.
5. Principles of industrial organisations.
By R. C. Choudhury
6. The development and capitalist enterprise in India
By Danial H. Buchanan.
7. Economic Problems of modern India,
By Radhakamal Mukherji &H. L. Dey
8. Industrial management.
By Asa. S. Knowles & Robert D. Thomson
9. Factory administration in practice.
By W. J. Hiscox.
10. Factory design and equipment and manufacturers of clay wares. By T. W. Garve.
11. Ceramic data book.
By Industrial Pablication Inc.
12. Modern Pottery Manufacture.
By H. N. Bose.
13. Principles of Chemical engineering.
Lewis, Mc Adams &Gilliland.
14. Report of the Industrial and fatigue Research Board. By H. M. Vernon & T. Bredford
No. 18. 1922.

15. Transactions of the British Ceramic society. The America Ceramic Society and The Indian Ceramic Society.

16. *Catalogues* :—(*a*) The Crossby machine Co. Inc.
(*b*) William Boulton Ltd.
(*c*) Wengers Ltd.
(*d*) August Reissmann A. G.
(*e*) Machinen Fabrik Dorst. A. G.
(*f*) S. G. Frantz Co. Inc.
(*g*) Rapid Magnetic machine Co. Ltd.
(*h*) The Eriez Manufacturing Co.
(*i*) Kusum Engineering Co. Ltd.